# PRACTICAL PLUMBERS' WORK.

# PRACTICAL PLUMBERS' WORK

*WITH NUMEROUS ENGRAVINGS AND DIAGRAMS*

EDITED BY

PAUL N. HASLUCK

HONOURS MEDALLIST IN TECHNOLOGY,
EDITOR OF "WORK" AND "BUILDING WORLD,"
AUTHOR OF "HANDYBOOKS FOR HANDICRAFTS," ETC. ETC.



CASSELL AND COMPANY, LIMITED

*LONDON, PARIS, NEW YORK & MELBOURNE. MCMV*

# PREFACE.

Practical Plumbers' Work contains, in a form convenient for everyday use, a comprehensive digest of information contributed by experienced craftsmen, scattered over the columns of Building World, one of the weekly journals it is my fortune to edit, and supplies concise information on the general principles and practice of the art on which it treats.

In preparing for publication in book form the mass of relevant matter contained in the Journal, much of it necessarily had to be re-arranged and re-written. The bulk of the matter and illustrations contained in this book were contributed by my old time colleague at Regent Street Polytechnic, Mr. J. Wright Clarke, the authority on Practical Plumbers' Work, and he has kindly revised the whole of the proofs of this present manual.

Readers who may desire additional information respecting special details of the matters dealt with in this book, or instruction on any building trade subjects, should address a question to Building World, so that it may be answered in the columns of that journal.

P. N. HASLUCK.

*La Belle Sauvage, London.*
*June,* 1905.

# CONTENTS.

# LIST OF ILLUSTRATIONS.

# PRACTICAL PLUMBERS' WORK.

## CHAPTER I.

### INTRODUCTORY: MATERIALS AND TOOLS USED.

A comprehensive treatise on plumbers' work would need a large volume; for the modern plumber is expected to supplement an intimate acquaintance with the common or immediate facts and principles of his craft by more than a smattering of applied science.

The title is taken from "plumbum," the Latin name for lead; whence plumber, a worker in lead. The origin of the craft is lost in oblivion, but references are made in Scripture to lead as material of commerce. In early times plumbers had to cast their own materials, such as sheets and pipes; sheet lead is used for roof coverings, such as "flats," "gutters," "flashings," etc., and pipes for the conveyance of water into or from houses. Cisterns and pumps were made and fixed by him, as were also lead coffins or wooden shells lined or covered with that metal, lead figures cast solid or with sand cores, and a variety of utensils. In the present day the plumber is still a worker in lead in a manufactured state, but he has had more responsibilities pressed upon him. In addition to being skilful in the manipulation of the materials he uses, he is regarded as a responsible person in all questions of domestic sanitation and water supply.

The duties of the plumber may be summed up under three heads: (1) keeping water out of houses (roof work); (2) getting water into houses, and storing and distributing it where required for use; (3) getting it out of houses after it

has served its purpose. In some places the plumber is also a painter, glazier, paper-hanger, gasfitter, hot-water fitter, bell-hanger, coppersmith, tinsmith, locksmith, etc. One book of convenient size cannot treat all these branches, and the scope of the present volume is restricted to working in lead.

Lead (chemical symbol Pb, an abbreviation of the Latin word plumbum) is the material chiefly worked upon by the plumber. It is made by roasting galena, a native sulphide (consisting of 13·3 parts of sulphur to 86 of lead) in reverberatory furnaces, at a dull red heat, by which most of the sulphide becomes changed by oxidation to sulphate. The contents of the furnace are then thoroughly mixed, and the temperature is raised, when the sulphate and sulphide react upon each other, producing a sulphurous oxide and metallic lead.

Lead mining is carried on in Derbyshire and the North of England, as well as in Cornwall, in the Isle of Man, and at Leadhills, in Scotland. Spain, however, with about 120 thousand metric tons annually, is the greatest lead-producing country in Europe, the other countries being arranged in the following order with respect to the quantities produced, the figures after each representing thousands of metric tons (the metric ton is equal to 0·984 imperial ton): Germany, 90; England, 67; France, 15; Italy, 10; Greece, 9; Belgium, 8; Austria, 6; and Russia, 1½. The annual output of the United States of America is reckoned at 110,000 tons; and of late years the annual output in Australasia has been reckoned at between 50,000 and 60,000 tons.

Lead melts at about 617° F., it expands greatly on heating, and does not always return to its original dimensions. The qualities that render it useful for such a large variety of purposes are its durability, easy fusibility, flexibility, malleability, and elasticity. It is oxidised by moist air, and pure water containing oxygen dissolves lead oxide when placed in contact with the metal; for which reason lead cisterns ought never to serve for collecting rainwater for domestic use. The basic acetate of lead formed by exposing the metal to acid fumes (as the vapour of vinegar) is decomposed by carbonic acid, forming a carbonate of lead, which, when washed and purified by levigation, is ready for use

as a paint—the well-known and universally applied white-lead. Litharge is obtained by oxidising lead in a reverberatory furnace, and the product, when further roasted, forms the higher oxide known as red-lead—also used as a

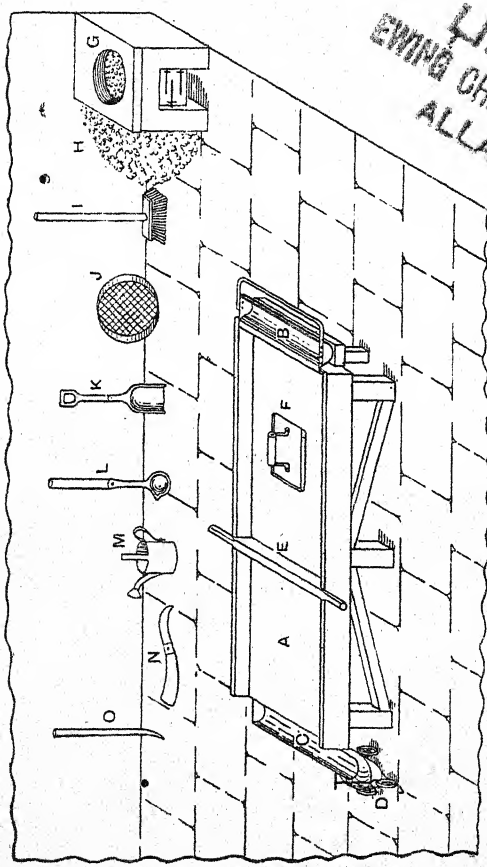



Fig. 1.—Sheet Lead Casting Shop.



paint. Lead has a specific gravity of 11·4; its atomic weight is 207.

It may be useful here to explain the expressions specific gravity and atomic weight. Specific gravity commonly

means the ratio of the weight of a body to that of an equal volume of water, the water being taken at a definite temperature, usually at the temperature at which its density is greatest—namely, 4° C (39·2° F.). Fownes states, however, that "in all cases of solids and liquids the standard of unity adopted in this country is pure water at the temperature of 15·5° C. or 60° F." The specific gravity of a substance is, then, the ratio of its density to that of the standard substance. In other words, specific gravity denotes the weight of a body, as compared with the weight of an equal bulk or volume of the standard body, which is reckoned as unity. In speaking of atomic weight, the standard of comparison is an atom of hydrogen, so that to say that the atomic weight of lead is 207 is to imply that an atom of lead is 207 times as heavy as an atom of hydrogen.

Lead comes into the hands of the plumber in a manufactured form as cast pigs, sheets, or pipes. The pigs of lead are generally the pure lead as it leaves the furnaces, and weigh from 1 cwt. to 1½ cwt. each. Sheet lead is either cast or milled. Fig. 1 shows all the appliances necessary for making cast sheets of lead. It is necessary to have a good-sized and well-lighted shop, with stone or paved floor; a "casting-frame" A made of wood and having its sides and one end raised; a metal trough with stoppered ends or "head-pan" B at the highest end; another trough with one stopped and one open end, called a "footpan," C at the lower end of the frame; a cast-iron melting "pot" G set in brickwork, and having flues round and a fireplace beneath, and a load or two of fine loamy sand. The tools used are two 28-lb. ladles L; a piece of board the same length as the width of the frame, and having handles projecting about 18 in. over the sides, called the strike E; a pair of "planes" F made of sheet copper with edges curved up and handles in the centre, similar to a square float used by plasterers; a waggon D which is a large bowl on wheels for conveying spare lead back to the pot; a "drawing-knife" N for cutting off the bottom edge of the sheet after casting; a pair of "sheet-hooks" O; a pair of "handspikes," and a couple of "rollers" for shifting the sheets after casting, or a swinging or small travelling crane for the same purpose; "felts" for holding the ladles, a broom I for sweeping up spilled lead, a "sieve"

J for screening the sand, a watering-pot M, and a couple of shovels K.

Milled lead is manufactured by casting a cake of lead and then passing it between large rollers until it is reduced to the desired thickness. Milled sheets are made from 20 ft. to 40 ft. long, and from 6 ft. 9 in. to 9 ft. wide. Sheet-lead is described as being five-, six-, or seven-pound lead. This signifies that one square foot of lead will weigh such a number of pounds. It is difficult to mill lead to a less thickness than 3-lb. (·051 of an inch), because of its want of tenacity. The weights of sheet-lead vary from 3 lb. to 14 lb. per foot super.; above this weight it is usual to describe the milled lead as plates.

In lead casting, the first operation is to fill the pot with lead and light the fire. The frame is then prepared by covering it with the sand, which has been sifted, wetted with water, and thoroughly mixed and spread evenly by means of the strike. After beating down with the shovels and again making even with the strike, the sand is "planed" until it is quite even and has a hard, compact surface. "Muffles" are then put on the handles to raise the strike off the sand bed, the thickness being according to the substance of lead required. The headpan, which is of the width of the frame and has a lip resting on the top end, is then filled with molten lead ladled from the pot. When the lead has cooled—until it ceases to scorch a piece of white wood dipped in it—two men take up positions at the top end, one on each side of the frame, and hold the strike in readiness; the contents of the pan are then upset by another man on to the frame, and the strikers immediately drop the strike on to the edges and run down to the bottom end of the frame, pushing the spare lead into the footpan, whence it runs into the waggon, and is dragged back to and emptied into the pot. Should the lead in the waggon be too cold for ladling, an iron ring or hook is partly immersed, so that when cold enough the lead can be lifted bodily into the pot. Immediately the strikers have done their part, a man with the drawing-knife cuts off the bottom selvedge so as to allow the sheet to contract, as it cools, without cracking. The lead is then rolled up and removed from the frame; the sand is sifted, re-wetted, and the whole proceedings repeated.

For making milled sheets, the lead is first melted in a large pot set in brickwork, and then run into a square mould, the size being according to the intended width of the sheet. An ordinary size is 7 ft. by 7 ft. by 6 in. deep. After being run into the mould, and while still molten, the lead is skimmed until all floating dross or dirt is removed. The cake of lead, which is of the size of the mould by 5 in. deep, and weighs about 7 tons, is allowed to set. It is then hoisted by means of a crane on to the mill, which consists of a frame usually about 60 ft. or 70 ft. long by 7 ft. 4 in. wide (some mills are larger, and can turn out sheets 9 ft. wide), with cross rollers the whole length of the frame, and two large steel rollers in the centre, one being above the other. These large rollers, with adjusting screws to regulate the space between them, are turned by powerful machinery. The cake of lead is run on the travelling rollers, then passed between the larger ones, which reduce it in thickness and make it longer. It is then drawn back by the large rollers, which have been adjusted closer together, and is further elongated and reduced in thickness.

When this process has been repeated until the sheet is about 1 in. thick, it is cut up by machine-worked shears into suitable lengths, according to the desired weights per foot of the finished sheets. These pieces, one at a time, are further rolled out and then folded, or doubled, in the middle and again rolled. The two sheets at the finish are each 34 ft. or 36 ft. long by 7 ft. wide, and weigh 4, 5, 6, 7, 8, or any other number of pounds per square foot. When the sheets are passing between the rollers for the last time, cutters are arranged at the sides of the frame to cut off the side edges; the ends are trimmed by hand. An iron mandrel is laid across each sheet, and the lead is dressed on to the mandrel, winch handles being subsequently fixed on the ends. These are turned by hand, and the lead is wound round them. The sheets are then corded and tied, rolled or hoisted on to a weighing-machine, and stamped with number, length, total weight, and weight per foot, after which they are ready for the market. The quality of lead may be judged by its softness and malleability, hardness denoting the presence of impurities. Plumbers tell the weight of ordinary sheet lead by simply feeling it with their fingers or measuring it with

their rule. The specific gravity of lead is 11·4; hence a square 1 in. thick weighs 59 lb., and for 6-lb. lead a square foot is about 0·1 in. thick. Some tool-makers keep notched gauges for the purpose, but the most accurate method is to square up the lead and weigh it.

Lead pipes used by the Romans were made of long strips of sheet lead bent cylindrical and joined at the edges. Haydn's "Dictionary of Dates" says that lead pipes for the conveyance of water were brought into use in the year 1236—in what country is not stated. It is quite evident, however, that they had been used long before that date. The pipes for the first London waterworks were of lead, and the works were built by a Dutchman named Peter Morris (or, according to a more probably correct version, Maurice), in the year 1582.

Up to the year 1741 lead pipes, so far as can be traced, had been made by hand, but in that year James Creed invented a machine for their manufacture on a large scale. This machine cut the lead up in strips to the width required for the given diameter of pipe. These strips were turned into pipes by means of rollers; between the rollers was placed a ball, which produced the inside diameter of the pipe, and at the same time the edges were scraped fit for soldering by a tool fixed on the frame which held the ball.

Lead pipes were first rolled solid in the year 1790. In that year, John Wilkinson, of Berwick-upon-Tweed, cast lead ingots in lengths, and put them on bars of iron, or of other metal harder than lead. These bars, or mandrels, as they are usually termed, he varied in length and diameter according to the size of pipe required. The mandrel, with the lead upon it, and extended to the length and thickness of the pipe manufactured, he passed repeatedly between rollers with grooves of different sizes, according to the external diameter required. He also claimed the process of drawing the lead ingots through metal gauges or dies of different diameters, after the lead has been placed on the mandrel, each succeeding die being less than the previous one, until the same was extended to the length and thickness required. The mandrel was then withdrawn, leaving a pipe of even diameter and thickness and of uniform length.

Knowledge of the deleterious effect of lead pipe upon

potable water induced many chemists and other ingenious inventors to attempt improvements upon the ordinary lead pipes, and amongst these are found lead pipes lined with tin, which invention was secured by patent to George Alderson in 1804.

One of the greatest—perhaps the greatest of all—improvements in lead and composition pipes was made by John Hague, in the year 1822, when he patented and introduced his solid pressing arrangement. The pipes manufactured upon this principle for gas and water supply services are now almost universally employed, especially for the former purpose. These pipes are forced out by means of hydraulic pressure through a die or core placed in the bottom of a cast-iron mould. Pipes of this description are much cheaper and much more reliable than those made in strips and soldered at the joints. In fact, Hague's patent completely revolutionised the lead pipe trade.

The hand-made lead pipe is made out of sheet lead, and the solid pipe is pressed out of solid lead by means of a pipe press, worked by powerful machinery. Each kind used as soil pipes has its advantages and advocates, and there is not much difference in efficiency and durability when the seam in the hand-made pipe is properly wiped or floated with ladle and iron. The machine-made pipe is the easiest to manipulate when it is necessary to make bends in it. When the pipes are used for conveying soft water, or acids, or other corroding agents, the seamless pipes are the best, as in some cases the solder is eaten away by the acids, and in others electrolysis sets up owing to two metals, lead and tin, being in contact in the presence of moisture.

Machine-made lead pipe is made now by pressing lead in a semi-molten state though dies by hydraulic machinery. The presses are of two or three different kinds. The commonest consists of a very strong cast-iron cylinder with closed top, in which are fixed the die and core of the size of the intended pipe. The bottom of the cylinder fits fairly tight, and slides up and down as it is pushed or pulled by a shaft connected to a piston in another cylinder beneath, which contains water under a great pressure. The piston being lowered, and the top chamber empty, the latter is filled with melted lead through an opening which is afterwards closed

with an iron plug and fastened. On turning on the water to the lower cylinder, the piston is forced upwards and the lead pushed out of the die at the top in the form of pipe. If small, the latter is wound on a wooden drum as it escapes; if large, it is supported by a cord attached to the upper end and carried over a pulley above, the free end being held tight by a man. The hydraulic pressure in the "ram," or lower cylinder, is from 1 ton to 15 tons per square inch, according to the size of the pipe being made. This pressure is derived from a series of pumps, worked by steam or other power, and is steadied by an "accumulator," which not only helps to keep the pressure even, but stores up the power in case of stoppage. Should the pumps be kept working when the pipe-press is stopped, gearing, attached to the accumulator, opens a valve to relieve the excess of water pressure, or throttles the supply of steam to the pumps.

To find the weight of a lead pipe of any thickness and diameter:—Rule: Subtract the square of the internal diameter of the pipe from the square of the external diameter—both in inches—and multiply the remainder by 3·86; the result will be the weight of the pipe in pounds per foot run.

The thickness of lead pipe required to withstand a given pressure may be calculated by the following rule: Multiply the head of water in feet by the radius of the pipe in inches and by ·433, and divide the product by 2,745, which latter equals the tensile strength of the lead in pounds per square inch. The result equals the thickness of pipe required in fractions of an inch. Or: Multiply the head of water in feet by the diameter of pipe in inches, and by 0·0000787. For each of these results a factor of safety of 10 is required, hence the last rule becomes:—

$$T = H \times D \times 0{\cdot}000787$$

in which T represents the thickness of the pipe in fractions of an inch.

The illustrations on pp. 18 and 19, Figs. 2 to 52, show a few of the tools that are in ordinary use. The name of each tool is given under its illustration, and further information, other than that obtainable in trade catalogues, is unnecessary. A large number of tools is necessary for special work, or work that has to be done under difficulties, or has complicated parts.

Fig. 3.—Straight Copper Bit.

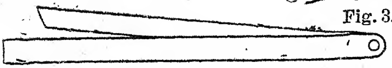


Fig. 2.—Adjustable Bevel.

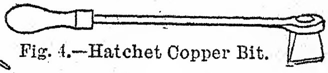


Fig. 4.—Hatchet Copper Bit.

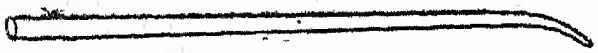


Fig. 5.—Brass Blowpipe.

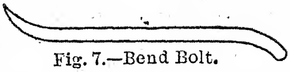


Fig. 7.—Bend Bolt.

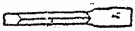


Fig. 6.—Cold Chisel.

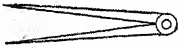


Fig. 9.—Compasses.

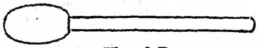


Fig. 8.—Hand Dummy

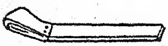


Fig. 10.—Catspaw Cloth.

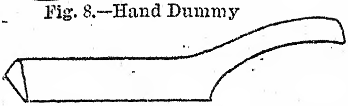


Fig. 11.—Dresser.

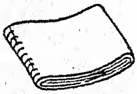


Fig. 14.—Wiping Cloth.

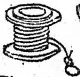


Fig. 13.—Chalk Line and Reel.

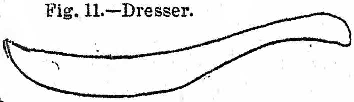


Fig. 12.—Bending Dresser.

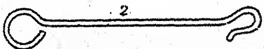


Fig. 16.—Quench Hook.

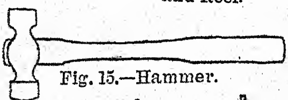


Fig. 15.—Hammer.

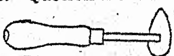


Fig. 17.—Shave Hook.

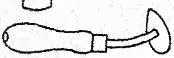


Fig. 20.—Bent Shave Hook.

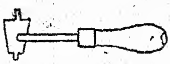


Fig. 19.—Gauge Hook.

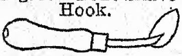


Fig. 21.—Spoon Hook.

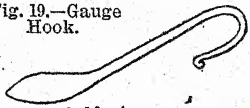


Fig. 23.—Soldering-iron.

Fig. 18.—Long Dummy.

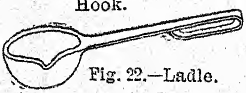


Fig. 22.—Ladle.

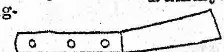


Fig. 24.—Chipping Knife.

Fig. 26.—Drawing Knife.

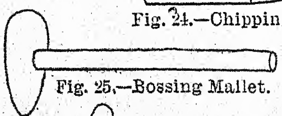


Fig. 25.—Bossing Mallet.

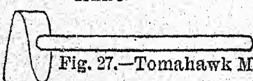


Fig. 27.—Tomahawk Mallet.

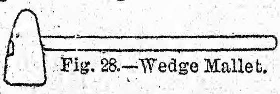


Fig. 28.—Wedge Mallet.

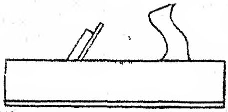


Fig. 29.—Jack Plane with Metal Sole.

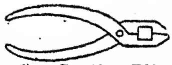


Fig. 30.—Cutting Pliers.

Fig. 35.—Two-hole Pliers.

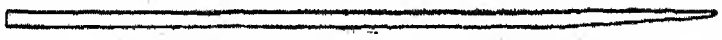


Fig. 31.—Steel Fixing Point.

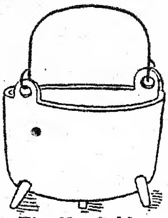


Fig. 33.—Solder Pot.

Fig. 32.—Shears.

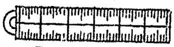


Fig. 34.—Rule.

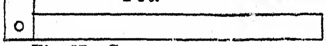


Fig. 37.—Square.

Fig. 36.—Rasp.

Fig. 38.—Screwdriver.

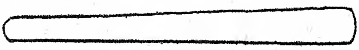


Fig. 39.—Bending Stick.

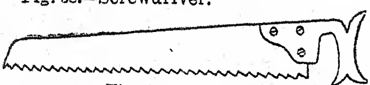


Fig. 40.—Saw.

Fig. 41.—Bossing Stick.

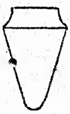


Fig. 44.—Large Turnpin.

Fig. 43.—Small Turnpin.

Fig. 42.—Setting-in Stick.

Fig. 45.—Bent Wedge.

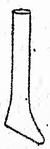


Fig. 46.—Narrow Bevel Wedge.

Fig. 47.—Wide Bevel Wedge.

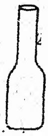


Fig. 48.—Narrow Chase Wedge.

Fig. 49.—Wide Chase Wedge.

Fig. 50.—Thumb Wedge.

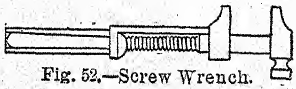


Fig. 52.—Screw Wrench.

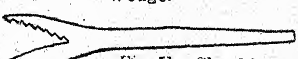


Fig. 51.—Shark's Jaw Wrench.

The following table is introduced to show at a glance the different thicknesses and weights of lead pipes commonly

| A | B | C | D | A | B | C | D |
|---|---|---|---|---|---|---|---|
| $\frac{3}{8}$ | Thin | $3\frac{1}{2}$ | 35 | $1\frac{1}{4}$ | Thin | 10 | 17 |
| | Middle | 4 | 32 | | ,, | 11 | 16 |
| | Strong | $4\frac{1}{2}$ | 28 | | Middle | 12 | 14 |
| | ,, | 5 | 24 or 48 | | ,, | $12\frac{1}{2}$ | 13 |
| | ,, | $5\frac{1}{2}$ | 22 or 44 | | Strong | 14 | 12 |
| $\frac{1}{2}$ | Thin | 3 | 39 | | ,, | 16 | 11 |
| | ,, | $3\frac{1}{2}$ | 35 | $1\frac{1}{2}$ | Thin | 12 | 14 |
| | Middle | 4 | 32 | | ,, | 14 | 12 |
| | Strong | $4\frac{1}{2}$ | 28 | | Middle | $15\frac{1}{2}$ | 11 |
| | ,, | 5 | 48 | | Strong | $17\frac{1}{2}$ | 9 |
| | ,, | 6 | 38 | | ,, | 21 | 8 |
| | ,, | 7 | 33 | $1\frac{3}{4}$ | Thin | 15 | 11 |
| | ,, | 8 | 33 | | Middle | 17 | 10 |
| $\frac{5}{8}$ | Thin | $4\frac{1}{2}$ | 28 | | Strong | 19 | 9 |
| | Middle | 5 | 24 or 48 | 2 | Thin | 19 | 9 |
| | Strong | 6 | 38 | | Middle | 23 | 7 |
| | ,, | 7 | 33 | | Strong | 26 | 7 |
| | ,, | 8 | 29 | | Thin | 19 | Barreling in 12-ft. lengths. |
| $\frac{3}{4}$ | Thin | 5 | 24 | | Middle | 23 | |
| | ,, | 6 | 20 | | Strong | 26 | |
| | Middle | 7 | 25 | | ,, | 30 | |
| | Strong | 8 | 22 | $2\frac{1}{2}$ | Thin | 26 | |
| | ,, | $8\frac{1}{2}$ | 20 | | ,, | 27 | |
| | ,, | 9 | 19 | | Middle | 30 | |
| | ,, | 10 | 17 | | Strong | 33 | |
| | ,, | 11 | 16 | 3 | Thin | 36 | |
| | ,, | 12 | 14 | | Middle | 42 | |
| 1 | Thin | 7 | 25 | | Strong | 44 | |
| | ,, | 8 | 22 | $3\frac{1}{2}$ | Thin | 45 | |
| | Middle | 9 | 19 | | Middle | 49 | |
| | ,, | $9\frac{1}{2}$ | 18 | | Strong | 52 | |
| | Strong | 10 | 17 | 4 | Thin | 48 | |
| | ,, | 11 | 16 | | Middle | 57 | |
| | ,, | 12 | 14 | | Strong | 61 | |
| | ,, | 14 | 12 | 5 | Thin | 73 | |
| | ,, | 15 | 11 | | Strong | 84 | |

manufactured, so that, when ordering pipes, the strength of pipe can be given when the weight is stated in the specifica-

tion. Column A shows the internal diameter in inches; B is the trade term indicating the strength of the pipe; C the weight in pounds per yard; D the average length in yards.

The plumber usually carries his tools in a bag made of carpet, with a smaller one for his wiping cloths, and sometimes another for his small tools. On country jobs a large box or chest is generally used, as a bag will not nearly hold them all.

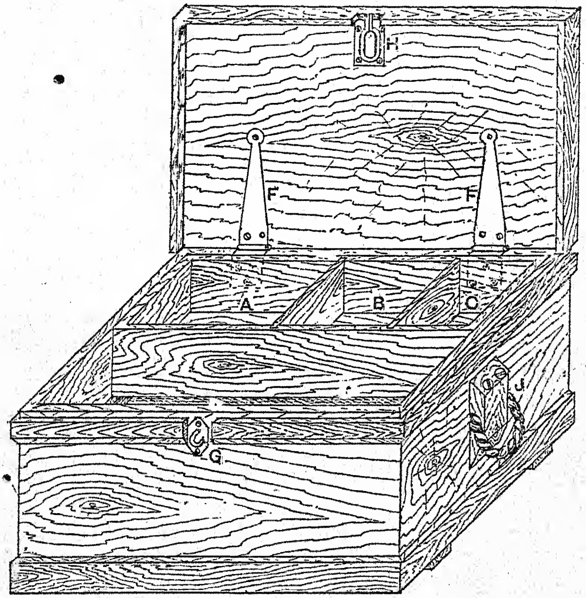


Fig. 53.—Plumber's Tool-chest.

The tools of a plumber are heavy, and a chest to hold them should be very strong. A chest to hold all that are used by plumbers would be very large, but a great many—such as long dummies, large ladles, pots, etc.—are not of sufficient value to be kept in a box. A plumber's ordinary kit of tools would go in a chest 2 ft. 6 in. long, 1 ft. 6 in. wide, and 1 ft. 2 in. deep (all inside dimensions). If a hot-water engineer's tools, such as stocks and dies, etc., are included, then the

box must be increased in size, or, better still, a separate one used. One reason for making the box strong is that, in addition to the weight of tools, plumbers do not always have proper lock-ups provided when working in new buildings, and their tool chests are convenient for holding a few articles such as cocks and valves, bar solder, and similar material.

The plumber's tool-box is made of yellow pine, $\frac{3}{4}$ in. thick when planed on both sides, with dovetailed angles,

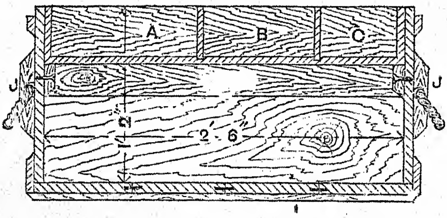



Fig. 54.—Side Section of Plumber's Tool-chest.

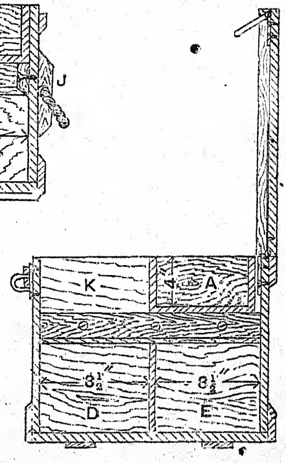



Fig. 55.—End Section of Plumber's Tool-chest.



plinth, and lid mouldings. The lid is clamped at the ends across the grain, and for the hinges box garnets are much better than ordinary butts. These box garnets are shown at F (Fig. 53). For fastening the lid, a staple and eyes, shown at G and H respectively, and a padlock are preferable to an ordinary box lock. The fastenings should be screwed on so that they cannot be removed by taking out the screws from the outside. For carrying the box, wood cleats, and loops or rings made of rope—the ends being spliced together—are very suitable, and better than small iron handles on plates. These are shown at J, in Figs. 53 and 54. Figs. 2 and 3 are sections lengthways and crossways.

A, B, and C, in Figs. 53 and 54, and A in Fig. 55, show a tray 4 in. deep made of $\frac{3}{4}$-in. deal, and having dovetailed angles; it is provided with divisions, and slides on deal fillets screwed on to the box ends. The division A is for small tools, such as pliers, small turnpins, gouges, hand chisels, etc.; B for wiping-cloths, and C for shave-hooks, drawing-knife, rule, and similar tools. The heads of shave-hooks should be rolled up in "felts" when being packed for carriage. The tray can be lifted out of the chest on to the bench during working hours, and the tools replaced from time to time after being used. This will obviate the cloths being made dirty or the shave-hooks blunted by being knocked about on the bench.

The lower part of the chest is divided by a partition into two portions (D and E, Fig. 55). One side is for boxwood and other tools used for lead-laying; the other is for hammers, long chisels, steel points, screw wrenches, spanners, and other metal tools. The lead-plane and saw should be placed in the former. The carpet tool-bag and plumber's overalls, when not wanted, can be packed on the front of the tray at K. The bottom of the box should have the grain of the wood running from back to front, and outside two fillets should be screwed on, with the grain running lengthways. These keep the chest clear of the floor, and also answer as runners when the chest is being dragged along, thus preventing the end plinth piece being forced off. The inside of the chest is left quite plain, but the outside should have three coats of oil paint, the finishing coat to be lead colour. As tool-chests are sometimes miscarried, it is an advantage to have the name and address of the owner, or the firm he works for, painted on the front, where it will be less likely to wear off than if painted on the lid.

A plumber's tool-bag, already referred to on p. 21, is usually made of good Brussels or other strong carpet, and it should have a lining of thin leather or strong canvas. Brussels carpet is about 27 in. wide, and a piece about $1\frac{1}{4}$ yd. long is the quantity required for an ordinary sized bag. The lining should be cut to the size required, so as to avoid a seam at the bottom, and should be closely sewn up the sides. The carpet should then be cut to suit the lining, allowance being made for seams and for about $2\frac{1}{2}$ in. to turn down at the top inside the leather; it should then be closely

sewn, wrong side out, with strong carpet thread, after which it should be turned, the leather lining put inside, and the $2\frac{1}{2}$ in. allowed at the top of the carpet turned down and closely sewn all round inside the leather. Holes should then be cut near the top, and eyelets, consisting of short pieces of compo. pipe, tafted to the carpet inside and out; a piece of sash cord is threaded through these eyelets for carrying the bag. In place of eyelets, short pieces of leather strap may be riveted to the top of the bag, with brass rings in them to pass the cord through.

## CHAPTER II.

### SOLDER AND HOW TO MAKE IT.

Plumber's solder, wiping solder, also sometimes called "metal," for use with the ladle and the soldering cloth, is made up by melting together pure lead and block tin in the proportion of 2 lb. of lead to 1 lb. of tin. Plumber's fine solder is made of about equal parts of those two metals. Strip solder—used with the copper bit—is made in the proportion of 2 lb. of tin to fully 3 lb. of lead. Gasfitter's solder may be made in the proportion of 8 lb. of tin to 9 lb. of lead; tinman's copper bit solder is 1 lb. of lead to 1 lb. of tin; pewterer's blowpipe solder is 1 lb. of lead, 1 lb. of tin, and 2 lb. of bismuth. The proportion of lead and tin may vary within certain limits without apparent effect on the solder.

Good plumber's wiping solder, when in a bar, should have a clean grey appearance, and not be dirty-looking; the ends of the bar should be bright, and show several tin spots mottled over their surfaces. In use, the solder should work smooth like butter, and not granular like wet sand. The tin should not separate from the lead, cooling in tears on the lower part of the joints. An ordinary test for the quality of solder is to melt it and then pour on to a cold but dry stone a quantity about the size of a five-shilling coin, and take note of the colour and also the number and sizes of the spots that appear; but the only reliable test is to make a joint and note the ease with which it can be worked or used. The blowpipe solder used for making joints in composition pipe should melt at a low temperature, or the pipe itself would be melted. For making blown joints on lead pipes copper-bit solder made in thin strips is generally used. This is the kind used also for soldering zinc. Some plumbers prefer solder finer, others coarser than the usual average which is given above.

The method of making solder as practised in the workshop is as follows: A 14-in. iron solder pot (Fig. 33) is sus-

pended over a coke fire, to which enough broken coke is added to bank up all round the pot. Sheet-lead cuttings and scraps of clean pipe are put into the pot until it is rather more than half full. Preference is given to pig-lead over sheet, and to new cuttings over pipe, because the lead rolled into sheets is generally purer than that used for pipe. Great care must be exercised to exclude compo. pipe, which often contains admixtures. Good composition tube is made nearly all of tin, or an alloy of tin and lead in which the former metal is in excess. But as much composition tube is made of old metals which contain lead, tin, antimony, arsenic, and zinc, it would be inadvisable to put such material in the plumber's solder-pot. The effect would be to raise the melting point of the solder, and in applying it to the joint to be soldered it would probably partially melt the lead. Moreover, the metals named do not alloy perfectly, but partake more of the nature of a mixture in which the constituents partially separate when making the joints; some, especially zinc, show as small bright lumps on the surface. Joints made with such solder, which usually is called poisoned metal, are difficult to form, and they usually leak when on water service pipes. The appearance of such joints is a dirty grey, instead of bright and clean as when good solder is used. From this it is clear that in making solder great care must be taken to exclude zinc from the pot. Zinc, lead, and tin do not alloy well; lead will unite with only 1·6 per cent. of zinc, and above that proportion the metals are only mixed when melted, and on cooling partially separate.

Sufficient lead having been melted in the pot, about ½ lb. of roll sulphur, broken into pieces about the size of hazel nuts, is added, and the whole well stirred with a ladle, the sulphur unites with zinc and other impurities. The resultant sulphides are skimmed off in the form of a cake, more sulphur being added so long as sulphides continue to form. Care must be taken not to let the sulphur fumes into the shop. The head of the ladle, in the intervals of stirring, is laid on the fire, to burn off any adherent sulphur. When sulphide ceases to be formed, a handful of black resin is thrown into the pot, and the lead stirred. When the resin has burned, the lead is again skimmed, and a piece of

Russian tallow about the size of a hen's egg is put into the pot, the lead being again stirred and skimmed. In stirring the lead it is lifted up and poured back by the ladleful, a larger amount of lead being thus exposed to the action of the cleansing material.

Best block tin is now added in the required proportion, and after the molten mass has been well stirred a little is run on to the hearthstone to test its fineness. If it appears too coarse more tin is added; if too fine, more sheet-lead. Finally, a little resin and tallow having been added, the solder is skimmed and is then ready for use or for pouring into moulds. When plumber's solder is heated in an open

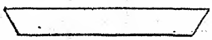


Fig. 56.—Side View of Ingot.

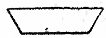


Fig. 57.—End View of Ingot.

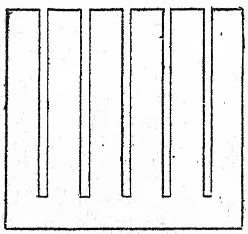


Fig. 58.—Top Side of Cast of Solder.

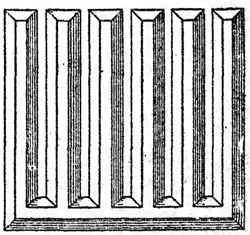


Fig. 59.—Bottom Side of Cast of Solder.

pot, the surface exposed to the air combines with oxygen, and on heating to redness, the combination takes place more readily. The tin melts at a lower temperature than lead, and its specific gravity is lighter, floats when melted, and so the solder becomes "poorer" when too highly heated, owing to the tin's oxidation. If the dross is melted with a flux, or with powdered charcoal, which will combine with the oxygen, the solder will again become fit for use, but it is sometimes necessary to add a little more tin.

Solder prepared as above described is run into small ingots of the shape shown by Fig. 56, a side elevation, and Fig. 57, an end elevation. The solder made in large quantities is generally run into a mould which produces a cast of solder resembling in miniature the "sow and pigs" of the

ironworker. This mould is shown by Fig. 58, a view of the upper side, and Fig. 59 of the under side. Fine solder, used with the copper bit for tinning brass, iron, etc., sometimes known as "half-and-half," because it is made of equal parts, by weight, of lead and tin, is cast into strips triangular in section. The mould used for this purpose is shown in plan in Fig. 60, and in cross-section in Fig. 61. Special care must be taken that everything put into a pot or ladle containing molten metal is perfectly dry. Anything wet introduced into the molten metal is sure to cause an explosion. The whole contents of the pot may be blown out to the danger of all within range.

Burning the solder must be carefully avoided. A pot of solder after it has been red-hot has always a quantity of

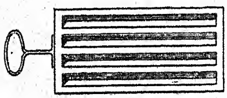


Fig. 60.—Plan of Mould for Strip Solder.

Fig. 61.—Section of Mould for Strip Solder.

"dross" or dirt collected on the top. This is principally oxide of tin and oxide of lead, the tin and lead having united with the oxygen in the atmosphere to form oxides of these metals. Lead being roughly 50 per cent. heavier than tin, the tendency is for the tin in the molten mixture to form the upper layer of the solder—the part most exposed to the action of the atmosphere. When the solder becomes red-hot, there is therefore more tin burned than lead. Hence the solder becomes too coarse, and more tin must be added. Zinc is the greatest trouble to the solder pot. Great care has to be taken to exclude it, or to get it out. It may get into the solder from a piece of compo. pipe having been put into the pot by mistake for lead; but more commonly brass, which is an alloy of copper and zinc, is the source of the zinc that "poisons" the pot, into which brass filings find their way whilst brass is being prepared for tinning. If the filing is done at the same bench as the wiping, splashes of metal may fall on the filings, which will adhere, and thus get into the pot. Solder that is poisoned by arsenic or antimony is beyond the plumber's skill to

clean; but zinc can be extracted by stirring in powdered sulphur when the solder is in a semi-molten condition, and then melting the whole, when the combined sulphur and zinc will rise to the surface, and can be taken off in the form of a cake, the solder being left in good condition for use.

The flux ordinarily used for plumber's wiping solder is tallow, generally in the form of a candle. No other fluxes answer this purpose so well, as they all spoil the wiping cloths, but different kinds of fluxes are required for different kinds of work. For a wiped joint, a tallow candle is rubbed over the parts. This is called touching, and is often practised in making copperbit joints; though for this latter purpose many plumbers prefer to use black resin. Spirit of salts is employed as a flux for use when soldering, the "raw" spirit—which is a powerful poison—being used for zinc or galvanised iron, and the "killed" spirit for other metals, such as brass, tinplate, copper, wrought-iron, etc.

After tinning brass with fine solder, the copper bit should be wiped quite clean, as the copper, uniting with some of the zinc in the brass, may affect the wiping solder. Some plumbers tin brass by holding it over the metal pot and pouring the solder on to it. This is bad practice, as the surplus solder, and any zinc with which it may have combined, fall into the pot. In cleaning solder, the sulphur must be used with more care than when cleaning lead, or the plumber will find himself burning out the tin as well as the zinc.

The method ordinarily adopted by plumbers for tinning iron is to file it bright and then coat the part with killed spirits or chloride of zinc, also called spirit of salts, in which zinc is dissolved, and then dip it into molten plumber's solder. Sometimes sal-ammoniac is used for the flux, or a mixture of sal-ammoniac and chloride of zinc. When wrought-iron pipes have been thus tinned, and then soldered joints made, they have been found to come apart after a few years, the pipe ends, when pulled from the solder, being found to be rusty. Although more difficult to accomplish, iron pipe ends filed and covered with resin, and then plunged into molten solder, from the surface of which all dross has been skimmed, and afterwards soldered

together, have been known to last a considerable time. When tinning the pipes or making the joints, the solder must not be overheated, or failure will result.

Fig. 62.—Plain Seam Soldered Joint.

Fig. 63.—Soldered Dot on Sheet Lead.

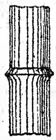


Fig. 64.—Blown, or Copper-bit Joint.

Fig. 65.—Section of Copper-bit Joint.

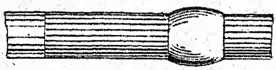


Fig. 66.—Wiped Pipe Joint.

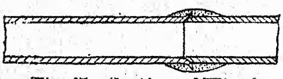


Fig. 67.—Section of Wiped Pipe Joint.

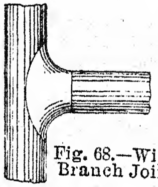


Fig. 68.—Wiped Branch Joint.

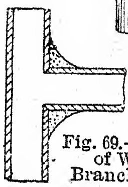


Fig. 69.—Section of Wiped Branch Joint.

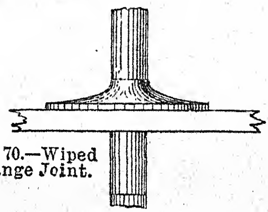


Fig. 70.—Wiped Flange Joint.

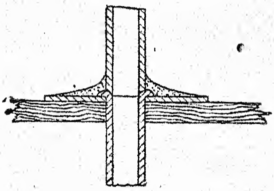


Fig. 71.—Section of Wiped Flange Joint.

Some of those soldered joints most generally used in plumber's work are illustrated by Figs. 62 to 71, shown above.

# CHAPTER III.

## SHEET LEAD WORKING.

THE first example to be discussed is the covering of wooden stairs with sheet lead. Each tread should have a separate piece, and in cutting out the lead for the straight tread add sufficient to the measurement to cover the nosing, and to lap on the riser below about an inch, and to stand against the riser up to the moulding beneath the next tread. The winding stairs should be set out full size in plan, the treads being shown and also the wall on one side and string or newel on the other. This will give the treads, to which allowances should be added as for the straight steps. If the setting out of the plan is a matter of difficulty, cut brown-paper patterns; one would do for all the straights, if of the same size, and one or more for the winders. Covering the risers with lead is a waste of both time and material.

The copper nailing is usually done at the ends, about 1 in. from the edge of the lead, with a single row at the back and a double or treble row where the feet rest on or near the nosings. The laps on to the riser below each step can also be nailed, but sometimes sheet-copper tacks, the same as for lead flashings on roofs, are used instead. The nails on the nosings should not be less than $1\frac{1}{2}$ in. apart, or the wood may split.

Nailing, although usually employed, is not entirely satisfactory, and it is much better to countersink the woodwork, dress the lead into the sinkings, and screw in brass plates about $\frac{1}{8}$ in. to $\frac{3}{16}$ in. thick and $1\frac{1}{2}$ in. to 2 in. wide, these being fixed flush about 9 in. or 10 in. apart, and about 1 in. back from the nosing. When the lead requires re-dressing or renewing, the plates can be easily taken off and refixed. A continuous brass angle-piece may be screwed in the angle formed by the tread with the riser. Felt or other material should not be placed under the lead.

The bossing up of a lead try or safe (Fig. 72) will now be described. A tray of this kind should always be fixed under a valve closet, so that if the closet is out of order, or if water is slopped over the side of the basin, the floor

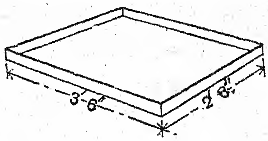



Fig. 72.—Lead Tray or Safe.

and ceiling beneath will be protected. When a tray with discharge pipe is provided, the water will be carried outside the house, and no damage will result. A tray 3 ft. 6 in. by 2 ft. 6 in. will be sufficient for any ordinary closet, and this size need not be exceeded generally. To make the lead tray a piece of sheet lead 4 ft. long and 3 ft. wide should be cut out and squared up. It should be marked off 3 in. on all sides, and lines drawn from A A to B B, and

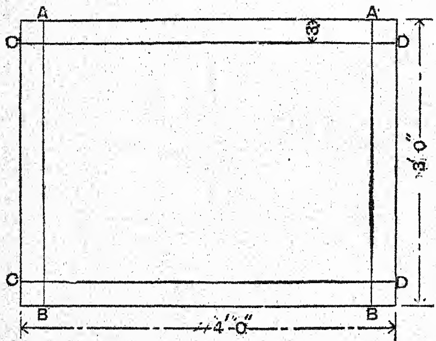



Fig. 73.—Pattern for Lead Tray.

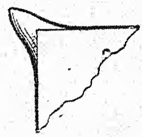


Fig. 74.—Corner of Lead Tray.

from C C to D D, as shown in Fig. 73, the margin thus marked being the sides, which are 3 in. high. Place a piece of quartering on the lines, and turn up the sides at right angles to the bottom. The corners will now appear as in Fig. 74. All bumps and buckles should now be

beaten out with a wooden dresser, and the lead all round the underneath edge of the tray should be knocked up to help to stiffen it whilst the corners are being bossed up. To knock up the corners, lay the tray on its end against the bench, with the underneath portion facing the worker. Take the bossing-mallet (Fig. 25, p. 18) in the right hand, and hold the dummy (Fig. 8, p. 18) in the left, underneath the corner; then with the mallet drive the lead gradually into the corner, taking care not to let it buckle. Great

Fig. 75.—Lead Bossing.



care is required in this part of the process, novices being apt to split the lead, or make a hole in the corner. After it is dressed into the required shape, see if the corner is at right angles with the bottom. A small piece of surplus lead will be found at the corner, and this should be cut off level with the sides. Serve all corners the same; then when well dressed and finished, the tray will have the appearance of Fig. 72.

The general procedure in bossing up internal and external corners in sheet-lead is to mark the lead where the

upstand is to be by indenting it with the side of a mallet. Set the external corner by working it up (say) $1\frac{1}{2}$ in. high with a small mallet and short dummy. An external corner, if alone, should be finished by working out the surplus lead with a bossing-stick, the fingers of the left hand only being held inside. As soon as the corner is set, put the stiffening creases into the lead about 2 in. from the upstand. For an internal corner the lead should

Fig. 76.—Lead Bossing.

be worked in from the corner of the sheet. When the internal corner is near an external corner, the lead should be worked from the external corner after it is half up. An internal corner should be begun by knocking up a bulge from below, and working the bulge into the corner, this operation being repeated as often as necessary until enough lead is gathered for the required thickness. The external corners must be kept well down, and not be allowed to drag upwards. The lead should always be kept rounded until the finish, when the arris may be put where

the operator likes. The lead should be kept of the same thickness all the time.

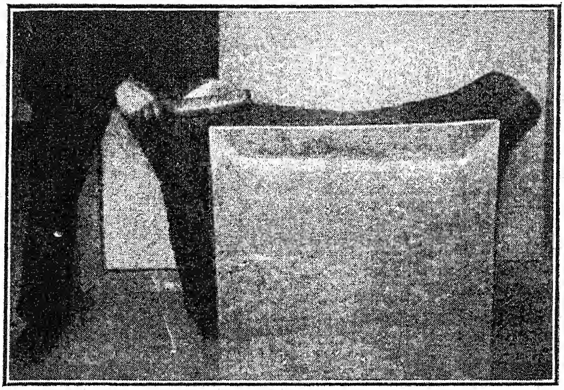


Fig. 77.—Lead Bossing.

Fig. 78.—Lead Bossing.

Reproductions of photographs showing different phases of the operation of lead bossing are given by Figs. 75 to 78.

A break is the piece of lead bossed up to fit against an

external angle of a wall or other projection. In Fig. 79 A C show corners, and B is a break. The lead in gutters and on flats is usually turned up against walls, etc., to a height of 6 in., and to make the lead stand against a break to that height is usually considered to be a difficult task. The lead has to be made to flow by forcing it into the angle from the outer edges. A skilled plumber has no difficulty in bossing a break, but skill is necessary to make one in which the lead is left of equal thickness throughout on completion of the work. The process can only be learned by constant and long practice.

The following is the best method of bossing-up sheet

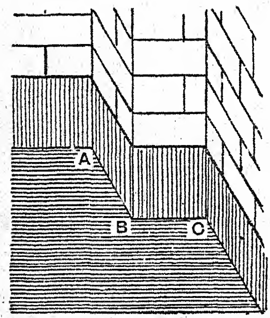



Fig. 79.—Diagram illustrating Break.

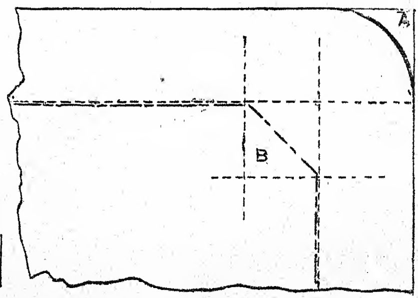



Fig. 80.—Sheet Lead Bossed up to Break.

lead to a break, the distance between external and internal corners being 3 in., and the upstand being 4 in. Dress the piece of lead flat, and then strike chalk lines 4 in. from each of the sides next to the break, and inside the angle formed by the lines measure 3 in. each way to represent the break, as shown by dotted lines in Fig. 80. Cut off the corner-piece on the thick line at A, and fold up the sides on the chain lines. Boss the lead into the internal angle B, and at the same time work up the two external corners. If carefully done, the lead will be of equal thickness in every part when finished.

When relining a sink, begin by stripping off all the old lead, and removing all the old copper tacks. As it

is always best to have a new waste-pipe, that also should be removed. The wooden frame should now be measured, and supposing it is 2 ft. long, 1 ft. 6 in. wide, and 1 ft. deep, a piece of lead 4 ft. 4 in. long and 3 ft. 10 in. wide will be required, this allowing for a 2-in. turn-down all round the top. Square all corners, then mark the height 1 ft. 2 in. from the edge on all sides; draw four lines through these marks as shown in Fig. 81, namely from A A to B B, and from C C to D D. The corner pieces E are to be cut out, which will give the required shape of the lining, as shown by Fig. 82. This should be painted with "soil" about 3 in. wide, as shown, and when dry, the edges, ½-in. wide, are to be shaved with a shave-hook. Care must be

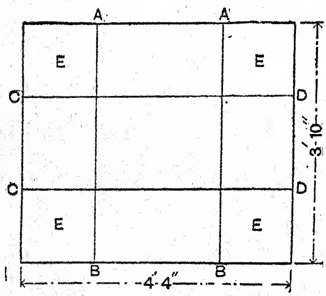



Fig. 81.—Pattern for Sink Lining.

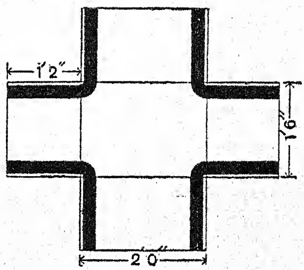



Fig. 82.—Lining of Sink.

taken that no part of the edges remains unshaven, as this would prevent the solder from adhering; and a tallow candle should be rubbed over it as a flux.

A piece of quartering about 18 in. long should be procured for use in turning up the sides at right angles to the bottom. The lining is now lifted into the frame and dressed to the sides, the corners and bottom edges being set in with a chase-wedge (Fig. 49, p. 19). A few copper tacks can be placed round the shaved edges to hold the lead in position, care being taken that their heads are bright, and the spare 2 in. of lead at the top can be turned outwards over the edges, and nailed with copper tacks. The corners C (Fig. 83) should have angle pieces left on 15 mitre on the top edge of the wood casing.

The sink is now ready for the angular joints to be soldered. Heat the metal-pot and plumbing-irons as described in Chapter V. (see pp. 66 and 71), and when the metal is melted take a ladleful, and with a splash-stick (Fig. 84), splash a sufficient quantity up the joint, warm it with the soldering iron, and wipe towards the worker, thus joining the sides together. The waste-pipe, which should be $1\frac{1}{2}$ in. in diameter, should now be fixed, and have a trap wiped on as shown in Fig. 85. Having cut the requisite hole in the lead bottom of sink, open the end of the pipe with a turnpin, boss it into the old hollow, and solder in the brass grating, soiling and shaving the lead round it and neatly wiping the joint.

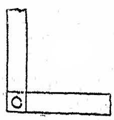


Fig. 83.—Corner of Sink.

Fig. 84.—Splash-stick.

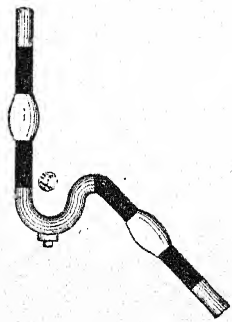


Fig. 85.—Waste-pipe with P-trap.

If the job were new, and the lining—instead of the relining of the sink—had to be undertaken, the work would be done in the following way: The hole through the bottom should be cut $\frac{1}{4}$ in. larger than the waste pipe, and it should be dished 1 in. all round $\frac{3}{4}$ in. deep (A, Fig. 86) for the grating washer and plug, or other fitting to be soldered in. If the lead bottom is neatly bossed into this hollow, it will be easy to wipe a clean edge all round when the waste is soldered in. At each angle B (Fig. 86) the top edge of the woodwork should be dished in the same manner, but $\frac{3}{8}$ in. deep, and the bottom must be arranged so that all the fall is to the waste, that all liquids may drain off.

Presuming that the sink has to be lined with lead the

same thickness throughout and in one piece, and that the wood case is made from 2-in. stuff, proceed to set out the lead preparatory to cutting out, taking for granted that the bottom and all angles are square or right angles, and the dimensions 2 ft. long, 1 ft. 6 in. wide, and 1 ft. deep. Take a piece of lead 4 ft. 4 in. by 3 ft. 10 in. as it is cut from the sheet, and proceed as already described, or adopt the following alternative method: Strike a chalk line A (Fig. 87) as near as possible to one of the longer edges, and parallel to this, another line B at a distance of 1 ft. 2 in., and from B another parallel line at a distance of 1 ft. 6 in., the width of the bottom of sink. On line A mark a point 1 ft. 2 in. from the left edge; place a set-square at this

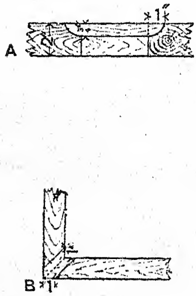



Fig. 86.—Dished Hole and Angle.

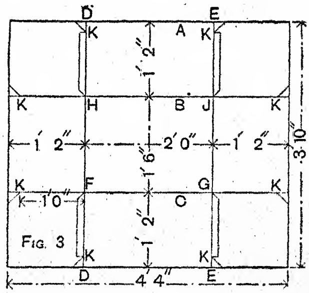



Fig. 87.—Pattern for Sink Lining.

point, and strike the line D D. From this line strike a parallel line E E 2 ft. distant. Now set the compass points 1 ft. apart, being the depth of sink, and from F G H J mark on the sides the points K, and cut out as shown, leaving the angle pieces at corners and the margin pieces at side. The ends should be pulled up first, then the sides, the margin pieces being dressed square. Keep well within chalk lines in setting up, as an allowance should be made for thickness of lead. A blow or two with a heavy mallet on the underside will belly up the bottom and allow the lining to drop in the wood case. When the edges are dressed over, the square corner pieces are worked into the sinking in the woodwork, and the top of angle can be wiped

flush. The edges should be nailed with copper tacks in straight lines at equal distances apart, trimmed to the face of the woodwork, and rasped or planed. The soldering is best done after the lining has been fixed. Soil the angles $3\frac{1}{2}$ in. on either side, forming a quadrant on the bottom, and, when dry, shave 1 in. wide; this will make the soldering about $1\frac{3}{8}$ in. wide. If the edges of lead are carefully punched into the angles, nailing is not necessary. When nails are used, the heads must be punched in below the surface of lead. It is advisable to wipe the metal from the bottom and bring it over the top edge, the sink being laid on its side for that purpose.

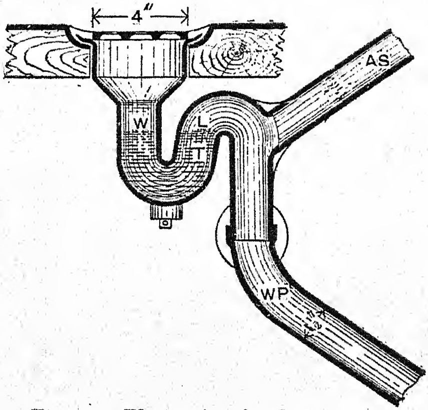



Fig. 88.—Waste-pipe for Lead Sink.

The waste-pipe can be arranged as in Fig. 85 (p. 38) or as in Fig. 88, in which W P indicates the waste-pipe; T, the trap; W L, the water line; and A S, the antisyphonic pipe. Many plumbers believe that the waste-pipe should not be less than $1\frac{1}{2}$ in. inside diameter for the size of tank given, and should have the trap soldered on with a cone piece at top to receive a 4-in. grating. These gratings can be hinged, so that the underside and trap may be cleansed. The water seal of the trap should be kept up as near as possible to the bottom of the sink, and should be ventilated by a $1\frac{1}{2}$-in. antisyphonic pipe.

It may be mentioned that a bell-trap is open to the

objection that when putting water down a sink, and finding it does not flow away quickly underneath the bell, a person will lift the loose bell grating, and this, of course, makes the trap insanitary, in fact, does away with the trap, and allows the foul air to come through the open waste-pipe. The bell is also liable to get knocked off the grating.

When the lead lining of a sink is to be bossed up instead of being soldered together, the sink may be of the section shown at A (Fig. 89). This is the best form for a

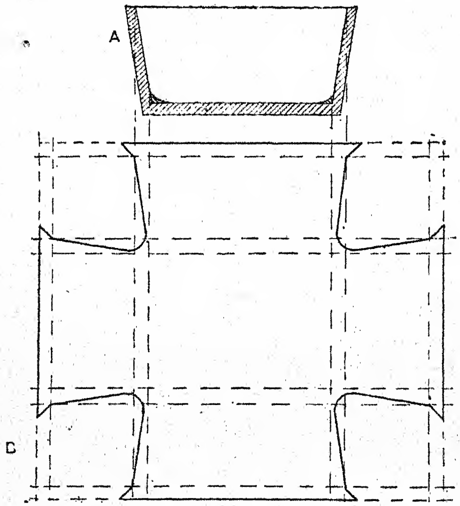



Fig. 89.—Section and Pattern of Lead Sink.

sink where hot water is laid on, the sides and ends sloping as in an ordinary wooden washing tray. The angles are occupied by hollowed fillets, and the lead is then bossed to fit. By this means, the lead is not fixed rigidly, and is allowed to expand. When the lining is to be soldered, the lead (10 lb.) is cut out in one piece as at B (Fig. 89). For a sink 2 ft. 3 in by 1 ft. 9 in. by 1 ft. deep, the lead at the bottom would measure 1 ft. 11 in. by 1 ft. 5 in. at each of the two sides, 2 ft. 1 in. by 1 ft. $1\frac{1}{2}$ in. (average); and at each of the two ends, 1 ft. 7 in. by 1 ft. $1\frac{1}{2}$ in. (average).

Allowance must be made for the angles on the top edge. The total amount of lead would be about $11\frac{1}{3}$ square feet, weighing (say) 3 qr. 27 lb. There would be a 4 ft. 10 in. run of soldering, weighing a further 6 lb.

Before instructions are given on lining tanks with lead, it must be said that there are objections to this being done; soft water, it is well known, dissolves the lead, and the habitual use of water containing more than $\frac{1}{20}$ gr. of lead per gallon is dangerous. Whilst one authority states that hard water, if free from organic matter, will not be affected by the lead, another authority says that potable water should never be kept in lead-lined cisterns. As a matter of practice, lead-lined cisterns should not be used; for though it may be true that water of a certain degree of hardness and free from organic matter is unaffected by lead, the foreign matters held in solution by water are not always constant. Drought and an abundant rainfall, as well as other causes, affect the quality of water, and where the health of the community is concerned every precaution should be taken to keep the potable water pure. Water containing less than 6 gr. of mineral substances per gallon is reckoned as soft water. All above that is called hard water; and to show what a great variation there is in the hardness of water it may be stated that water in the neighbourhood of London is said to contain about 18 gr. of chalk in each gallon. If lead-lined cisterns must be used, they should be regularly cleaned out. For the sides, the weight of the lead should not be less than 6 lb. per foot, and then for the bottom it would be an advantage to use 7-lb. lead. Iron bolts that are used as ties to strengthen the cistern should be encased in lead pipe, the ends of which can be soldered to the sides of the cistern. Wood cisterns lined with zinc are sometimes used, but it is questionable whether there is anything beyond their cheapness to recommend them.

Limewhiting lead, iron, or galvanised iron cisterns has been found to arrest the corrosive action of some kinds of water. The limewhite should be made from freshly-slaked lime and used at once, and size, oil, or other mixture is not required with it. The wash must be allowed to dry before filling the cistern with water, and renewed whenever the cistern is cleaned out.

6341

A suggestion as to the best method of constructing a lead-lined cistern is given in Fig. 90, which shows a framed and dovetailed cistern, 7 ft. long, 3 ft. wide, 2 ft. deep, to be lined with 6-lb. lead. The illustration gives an isometric view showing the cistern ready for lining. The sides are formed of three boards jointed, ploughed, and cross-tongued. For the purpose of breaking joint, the ends have to be formed of two boards and two half-boards as shown. For a cistern of this length one or two top ties should be dovetailed to the sides after lining. Often metal tie-rods are employed, and of these wrought-iron is the cheapest,

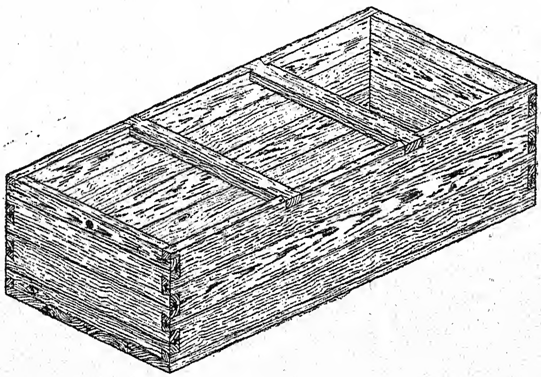


Fig. 90.—Cistern for Lead-lining.



but copper better resists any corrosive action or rusting. Holes should be bored through the cistern on opposite sides where the rods are to be fixed, and the rods passed through the holes and also through lead pipes fixed between them. The ends of the pipes are wiped to the lead linings, and the bolts are to have a head on one end and a screwed nut on the other for tightening them. The heads and nuts respectively should have wrought-iron plates between them and the wood casing, to strengthen the latter and distribute the strain over a larger area.

In lining a wooden tank with lead, the dimensions of the tank being 20 ft. by 9 ft. by 4 ft. deep, the bottom should be divided in its length into three parts. This

would give two seams across the bottom, and where the seams come the woodwork should be dished for the soldering to be wiped flush. The lead for each end of the tank can be in one piece, and if plenty of help is available, the sides could also be each in one piece. But if the tank is in a cramped position where the extra hands cannot exert their full strength, each of the sides can be lined with two pieces, dishings being made in the woodwork for flush seams to be wiped upright in the centre of their length. For rainwater, the sides and ends should be of 7-lb. lead, and the bottom of 8-lb. lead; but if economy must be studied, 6-lb. lead sides and ends, and 7-lb. lead bottom, would do. To line the tank, first put in the sides, then the ends, and the bottom last of all. After the lead is in position, the upright flush seams and the upright angles should be soldered, then the bottom flush seams, and lastly the bottom angles. The laps must be arranged so that the solder will not run through when wiping. Upright stiffening pieces wiped to the sides are better than soldered dots; but if it is found necessary to fix stay rods to keep the wooden sides from bulging outwards, these rods would also help to support the lead, and prevent it from bagging inwards as the tank is emptied of water.

Plumbers do not agree as to the amount of solder they use when wiping angles, but about $1\frac{1}{4}$ lb. to $1\frac{1}{2}$ lb. of solder is a fair average per foot run for a cistern lined with 6-lb. lead. A thoroughly good lead-burner, who is paid about half as much again as an ordinary plumber, would line and burn a large cistern in about the same time as if it were soldered. Under ordinary conditions either method would do, but where the water has a solvent action lead burning is better than soldering. Pure lead resists the action of water more than ordinary lead, and can be burned much better. With soldered angles a voltaic action takes place between the metals lead and tin; with burned seams there is only one metal, and consequently no voltaic action.

To prepare a slate cistern for lining with lead, the angles that are to be wiped should be lined with wood. Boards 6 in. to 8 in. wide and 1 in. thick should have one face planed down to a feather-edge, the feathering extending half-way across the board to leave 3 in. or 4 in. level on the top, so that the solder will not run away from

the angle when wiping. The wood linings should be carefully fitted, the flat side being downwards and the feathering towards the inner parts of the cistern, and mitred at the corners so that they will mutually keep each other in position at the bottom, and they should be skew-nailed to each other on the tops of the upright angles. If the means of access to the cistern are awkward, the sides had better be in four pieces, necessitating four upright angles being wiped. After lining the angles with wood, the cistern can be lined with lead in the ordinary manner.

Copper with tinned face is far preferable to lead for lining sinks in which hot water is used. The copper lining should be made the exact depth of the wood casing, but the length and width about $\frac{1}{4}$ in. smaller, so that it is free to expand without buckling in the bottom. The best weight for the bottom is 3 lb. to $3\frac{1}{2}$ lb., and for the sides $2\frac{1}{2}$ lb. to 3 lb. per superficial square foot.

In lining a sink with pewter, the sheet pewter should be cut out to such a shape that as little soldering as possible has to be done. In this case, the corners can be cut out, the metal folded to fit the case, the soldering done on the outside and cleaned off before placing in position; the soldering is done by means of a copperbit or a blowpipe. The solder is composed, by weight, of 1 lead, 1 tin, and 2 bismuth, and the flux is Gallipoli or olive oil. Soldering trials should be made on pieces of spare pewter before attempting that on the sink.

# CHAPTER IV.

## PIPE BENDING.

In bending a lead soil pipe, where the pipe overlaps in the throat (see Fig. 91), it will be seen that there is a surplus of lead to be disposed of, and where the parts do not meet, at the heel, there is a deficiency to be provided for. When the bend is completed, the lead should be of equal thickness in all parts, and this can only be attained by working the surplus lead from the throat to supply the deficiency at the heel.

The tools necessary are a boxwood mandrel (Fig. 92), which should be about 15 in. long; a boxwood bending

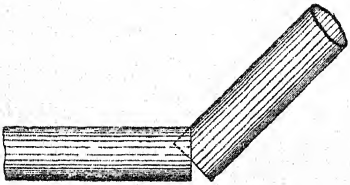


Fig. 91.—Diagram showing Bending of Lead Pipes.

Fig. 92.—Boxwood Mandrel.

dresser; a soft-wood dresser; a boxwood mallet with cane handle; a dummy A, Fig. 93, with a cane handle; dummies B and C, Fig. 93, cast on ½-in. steam barrel, with heads at different angles to the handles; and lead flappers as Fig. 94, but of different widths. A flapper is made from a strip of sheet lead by folding up a part of it to form a handle.

The cane dummy is made by covering 3 in. of the end of the cane with sheet lead, or lead pipe, fastening the lead securely to the cane with tacks, shaving the lead very carefully all over, and wiping on a bulb of solder of the shape required.

The long dummies are made by tinning about 2 in. of the iron barrel at one end, making an impression of the

head of the cane dummy in a gallipot of sand, holding the tinned end of the barrel in the centre of the impression so made, and pouring wiping solder into the mould. The solder will unite with the tinning on the barrel, and the head will be secure. The heads should be trimmed, the sharp corners being well rounded off. It is better to bend the barrel to the required angle before tinning it. File the iron barrel bright where it is to be tinned, and paste a piece of paper round the edge where the tinning is not required, moisten with killed spirits of salts (muriatic acid saturated with zinc), and apply fine solder with the copper bit. After tinning, thoroughly wash the end of the barrel in clean water, to remove all traces of the acid.

Put the lead pipe to be bent (say 4 ft. of 4-in.) on to the

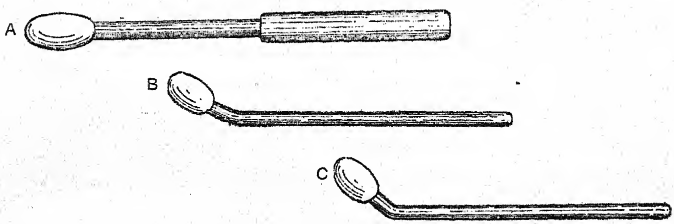



Fig. 93.—Dummies.

bench, first taking care that the bench is perfectly clean and clear of all grit, nail-heads, or anything that would mark the pipe. Dress it straight, drive the mandrel through so as to ensure a perfectly regular bore and to take out any indentations, and dress the pipe on to the mandrel during its passage by beating it with the lead flappers. A little linseed oil applied to the inner surface of the pipe will render the passage of the mandrel easier. Having dressed the pipe straight, mark where it is to be bent by striking it smartly with the bending dresser. One man must now, with a mandrel or a dresser, bear down on the place marked, whilst the other man lifts up the pipe at one end. This serves to bend the soft pipe, the pressure of the mandrel deciding at what point. It is not wise to bend the pipe too much at one operation (Fig. 95 suggests the successive stages of pipe bending).

Little and often is much the safer plan until experience has taught a man how much of a "pull-up" he can manage.

When the bend appears as in Fig. 96, strike the pipe with the bending dresser at the places marked x-x. This will make the contraction more gradual, and render it easier to dummy out without buckling. For working with the dummy, the pipe is held in the position shown in Fig. 96, the end being placed against a strip of wood about 1 ft. long, 2 in. wide, and 1 in. thick, which is nailed on the end of the bench. Upon the handle of the dummy being struck smartly on the strip of wood, its head will strike upwards against the inside of the pipe. By striking repeatedly at the inside of the indentations the original bore of the pipe is restored. This having been done, lay the pipe first on one side, then on the other, and drive back

Fig. 94.—Sheet-lead Flapper.

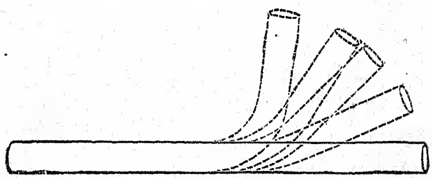


Fig. 95.—Successive Stages of Pipe-bending.

the cheeks to the heel with the dresser. Now work up the sides with the dummy, and the pipe will be ready for another "pull up." In case of doubt as to the thickness of any part, the bend should be tapped lightly with the mallet, when the sounds will indicate where it is too thick or too thin. Where it is too thick it must be worked up with the dummy, which stretches the lead and of course reduces its substance, and the bulge thus raised is worked towards a place that is too thin. The bend should be made of larger bore than the pipe, and then dressed into the exact size with lead flappers.

Except for single bends, where all parts can be easily reached, the beginner will find it best to finish off by putting a bobbin through. A bobbin is made of boxwood of the form shown at A (Fig. 97). A sash-line passes through a hole in the centre. The line also passes through a weight B (Fig. 97), to which it is fastened. The bobbin being

inserted, the weight is drawn backward and forward by the line passing through the pipe. Each time the weight is pulled forward it strikes the bobbin and is drawn back again for another blow.

Fig. 98 shows a section through a weight, which is composed of solder cast in a mould made by dressing a piece of 3-in. pipe to the required shape, cutting it through lengthwise, soiling the inside, putting in a wood core, and binding the two halves together tightly. When the weight has been cast, the mould comes off in two halves, and the core is taken out with a gimlet. A brass disc is soldered

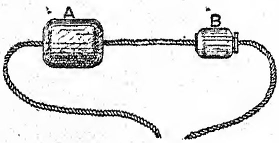



Fig. 97.—Bobbin, Weight, and Cord.

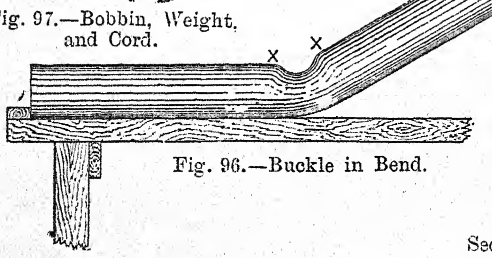



Fig. 96.—Buckle in Bend.

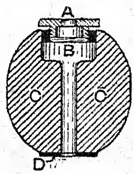



Fig. 98.—Section of Weight.

on to the end that strikes against the bobbin, and a brass trap screw, with a hole through the plug, is soldered into the other end. Half the line is passed through the weight, a knot is put into the middle, the knot is drawn into the recess under the trap screw, the line is passed through the plug of the screw, which is then screwed down on the knot, and the weight is fastened on to the line. As the bobbin passes through, the pipe is dressed on in the same way as it was dressed on the mandrel. In Fig. 98 the references to the lettering are as follows:—A, brass trap screw; B, recess in which knot is held; C, body of weight, made of wiping solder; D, brass disc for striking against bobbin.

The bobbins may also be driven through the pipe by means of short pieces of wood a little smaller than the bobbins, and long wood rods. Or the bobbins may be driven through by allowing a lead ball to fall upon them. Another method is to drag them through by means of a cord knotted at one end, and passed through a hole made in the centre of the bobbin. High-class plumbers rarely use these appliances, as by their use the heel, or outside, of the bend is made thinner than the other parts.

If lead pipe is very hard, it can be softened by burning a few wood shavings inside the bend, the throat being uppermost. A better and cleaner method is to chalk the bend well, and then pour on a small quantity of molten lead, which, when set, can be easily tipped off with the finger. The dummying should be quickly done while the pipe is hot. Some plumbers prefer to use a blowlamp, as

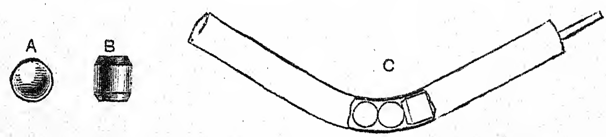



Fig. 99.—Ball and Follower, and their Use.

the heat can then be directed more definitely to the place where it is wanted. The lead pipe should be made just hot enough to make a fizzing noise when a drop or two of water is allowed to fall upon it.

Bending with balls and followers is a method that was followed much more some years ago than it is at the present day. It is not considered a good way by first-class plumbers. The piece of pipe to be bent is pulled round a little till it dents in the throat; two or more hard-wood balls A (Fig. 99), slightly smaller in diameter than the bore of the pipe, are then inserted in the pipe, and driven past the bend by means of some short round blocks of wood, called followers B (Fig. 99). This takes out the dent caused by the bending; C (Fig. 99) will assist the reader in understanding the process. The pipe is then bent again, and the process repeated until the required angle is obtained. The objections to this method of bending are those that

apply to the use of ordinary bobbins: the pipe is weakened at the heel of the bend, and is liable to be damaged by the edges of the followers catching in the angle of the bend. However, if the followers are well rounded off, as

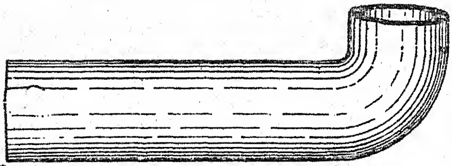


Fig. 101.—Lead Elbow.

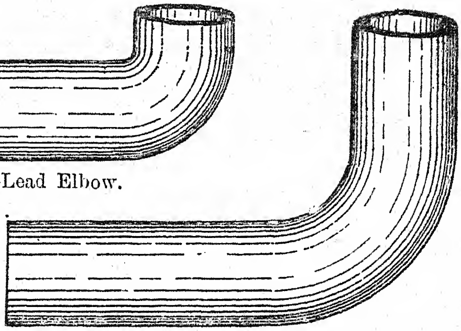


Fig. 100.—Lead Bend.

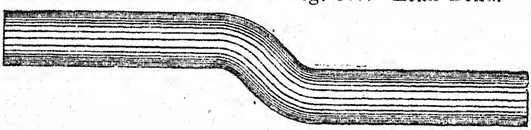


Fig. 102.—Offset on Soil-pipe.

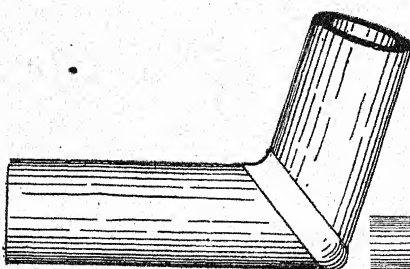


Fig. 104.—Soldered Elbow.

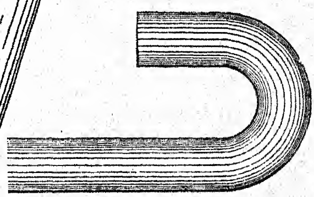


Fig. 103.—Return Bend.

shown in Fig. 99, and both them and the balls well greased, there is very little fear of that happening. Of course, if this method is adopted, a set of balls and followers will be wanted for each size pipe that it is required to bend; the most useful sizes for lead pipes are from $1\frac{1}{2}$ in. to 3 in.

diameter; above or below these sizes, balls and followers are not recommended.

By winching lead pipe bends it is understood that a bobbin with a rope through it (as already described) is dragged through the pipe and bends by means of a winch fixed on the end of a bench. This is sometimes practised instead of using followers and driving-rods to force the bobbin through.

The method just described of bending soil or funnel pipes will not be suitable for small bore pipe such as is used for water service, overflows, etc. Strong lead service pipe, up to 1 in., can be easily bent by pulling round, if the bend is not made too sharp, and the plumber should

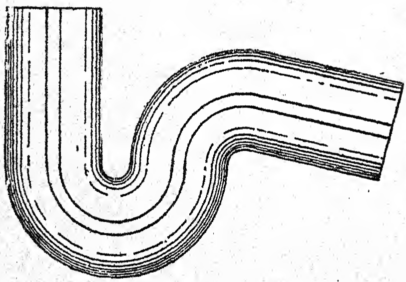


Fig. 105.—Hand-made Trap.

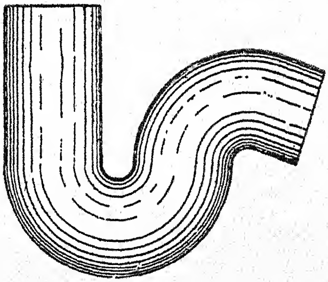


Fig. 106.—P-trap.

always make his bends as easy as possible. When a sharp bend has to be made in a long piece of pipe, it is best to cut the pipe near to the place at which the bend is to be made; then, when pulling round, if the throat contracts, it can be worked out to its proper size by means of what is called a bolt or tommy. This is made of iron or steel, with the ends well rounded and quite smooth, and is illustrated by Fig. 7, p. 18.

Some plumbers adopt the water or sand method for bending small pipes. In the former method the water should be poured in hot, and the ends plugged tightly or flattened close, and the soldering-iron run over the ends to keep the water from bursting out when the pressure of bending comes on it. In bending with sand, the sand may either be put in hot, or the pipe can be heated in the

place where the bend is required. When filling with sand, one end should be plugged, then the sand rammed in as tightly as possible till the pipe is nearly full, and the other end then flattened or plugged. Pipes should not be bent over anything sharp, but should be "humoured" as much as possible. The essential requirement is to keep the pipe full size at the bend, otherwise its effectiveness is reduced.

Lead pipe is bent into a variety of shapes, and Figs. 100 to 103 show four of the chief. An ordinary right angle bend is shown by Fig. 100, a lead elbow by Fig. 101, an offset by Fig. 102, and a return bend by Fig. 103. The elbow shown by Fig. 104 is not an example of bending;

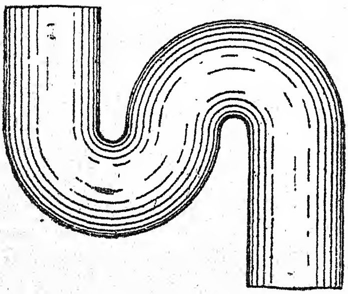


Fig. 107.—S-trap.

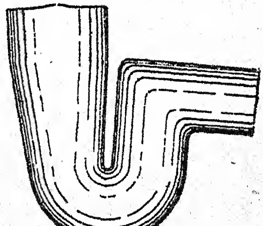


Fig. 108.—Anti-D-trap.

it is made by mitring the ends of the two pieces of pipe and then joining them with solder. Traps capable of being made by bending lead pipe are shown by Figs. 105 to 108, Fig. 105 illustrating the genuine homemade trap; the inscriptions give sufficient descriptions of the others.

Sometimes a pipe bend is made out of sheet lead; for example, by the following method, a lead bend can be made in halves out of 5-lb. sheet lead, and afterwards joined. The lead must be cut to the length, measured outside, of the finished bend, and the width must be equal to half the circumference of the pipe. Thus, if the bend is to be 4 in. in diameter the lead should be $\left(\frac{4 \times 3 \cdot 1416}{2}\right) =$ 6·28, or say $6\frac{3}{8}$ in. wide. The edges must then be made

perfectly straight by rasping or by planing, and the pieces dressed on a 4-in. mandrel (a piece of 4-in. cast-iron rain-water pipe will serve the purpose), the place at which the bend is to be made being marked with chalk. One piece must be bent to the required angle, in order to form the keel or outside of the bend; this will cause the sides to bulge outwards, and the bulge must be corrected by bossing the sides inwards to the desired extent, which will cause a slight thickening. The straight parts or ends must be kept to the right curve by frequent dressing on the mandrel. The other piece of lead must be bent the reverse way in order to form the throat of the bend; and the bulged sides must be worked outwards in order to form the other half.

Unless great care is taken in working the sides of the second half, the lead will be so reduced in thickness that it will break or tear. To lessen this risk as much as possible, the hollow in the throat should be worked outwards, which will cause that part to be slightly thickened. After the two halves have been bossed to shape, the edges must be trimmed and accurately fitted together, then soiled inside and outside for a width of about 2 in., and shaved with a gauge-hook for a width of $\frac{3}{16}$ in. to $\frac{1}{4}$ in., when the seam is to be $\frac{3}{8}$ in. or $\frac{1}{2}$ in. wide. The halves must then be laid in position on the bench, and the seam made by drawing with metal and a plumber's iron. The bend should then be turned over and the other seam soldered in a similar manner. Before beginning to make the bend draw the required shape with chalk on the bench, in order that the correct angle may be ensured. When many bends have to be made, a wooden or a cast-iron block, on which the halves can be worked, should be provided.

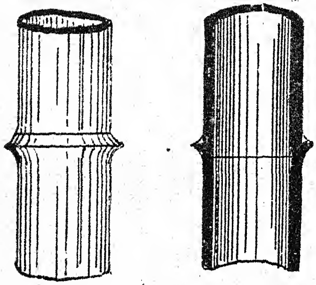
# CHAPTER V.

## PIPE JOINTING.

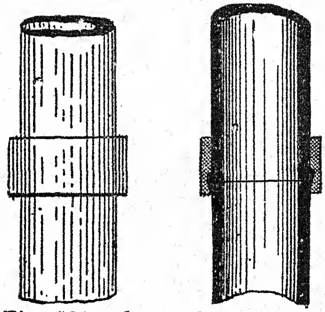
THE two or three commonly employed processes of jointing lead and composition pipes will be the better understood when the styles and shapes of the principal joints have been illustrated. Figs. 109 to 138 have been prepared to show these joints in elevation and section, and the inscription beneath the figures will serve equally as well as a lengthy description in the text. Figs. 139 to 141 show the application of some of these joints.

Wiping joints, like other skilled arts, can only be learned by practice. But although the requisite skill of hand cannot be imparted, there are still many points upon which practical hints may prove helpful.

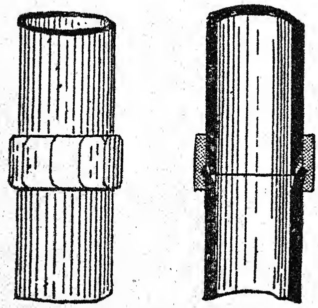
Wiped joints are of two kinds, horizontal or underhand, and upright, and it is commonly thought that the easiest way to make a horizontal joint is to roll the soft metal into shape. However, it is just as easy for a good plumber to make an ordinary underhand joint as it is to make a rolled joint. A rolled joint can only be made in a straight piece of lead pipe which can be rolled round on the bench. An underhand joint can be made on a horizontal pipe with bends in it, and when fixed in position. To make a rolled joint, the ends of the lead pipe are prepared as for any other method, and then secured to each other by means of "splints." These are pieces of thin board, or, better still, pieces of straight plasterer's laths, split up and pushed into the parts to be joined, so that the whole is as rigid as if it were one piece of pipe. After preparing the ends, the work is laid on two pieces of deal quartering 3 in. or 4 in. square, and about 2 ft. to 3 ft. long, laid crossways on the bench, so that the pipe can be rolled backwards and forwards on the blocks. If the joint is a small one, the plumber can manage by himself, and begin by pouring on the metal as for an underhand joint. When his heat is about right, he then with one hand holds



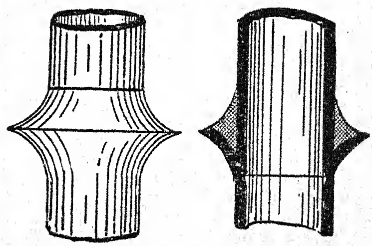
Figs. 109 and 110.—Copper Bit Joint.



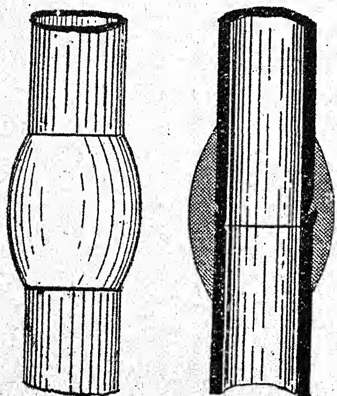
Figs. 111 and 112.—Ribbon Joint.



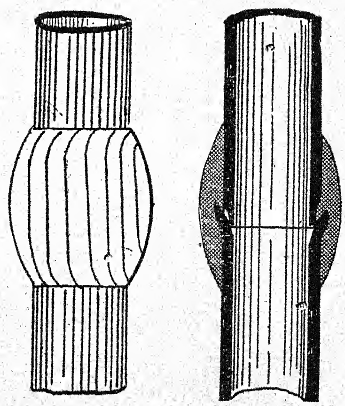
Figs. 113 and 114.—Copper Bit Overcast Joint.



Figs. 115 and 116.—Flange Joint.



Figs. 117 and 118.—Wiped Joint.



Figs. 119 and 120.—Overcast Joint.

the cloth on the top of the solder, and rolls the pipe away from him with the other hand. He then lifts off the cloth, quickly rolls the pipe towards himself, replaces the cloth in position, the wiping hand having the fingers spread open to give the joint the proper roundness, and again rolls the pipe away from him. This process is repeated two or three

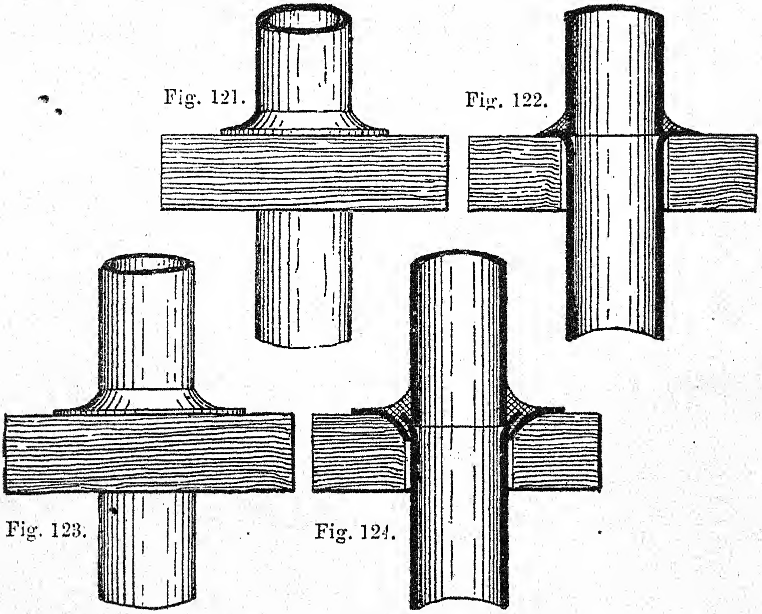


Fig. 121. Fig. 122. Fig. 123. Fig. 124.

Figs. 121 and 122.—Block Taft Joint. Figs. 123 and 124.—Block Flange Joint.

times, until the joint is of the right form and the solder is on the point of setting.

Another way of making a rolled joint is for the plumber to use an upright, instead of underhand, cloth, which he holds on the near side of the joint, at the same time pouring solder on to the pipe and cloth whilst his mate slowly rolls the pipe towards the front side of the bench. On getting to that position, the mate quickly rolls the pipe to

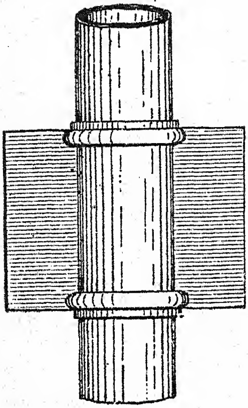


Fig. 125.—Astragal Joint.

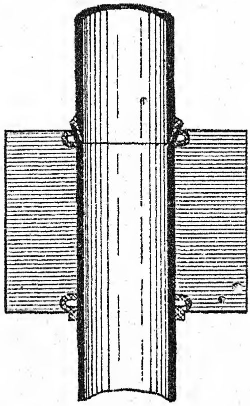


Fig. 126.—Astragal Joint.

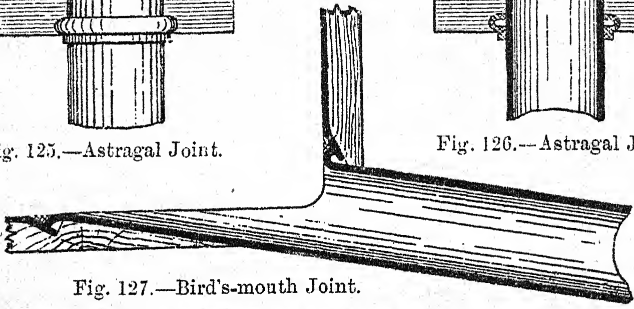


Fig. 127.—Bird's-mouth Joint.

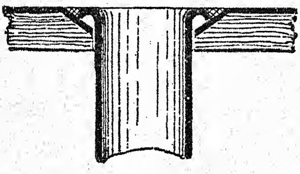


Fig. 128.—Taft Joint.

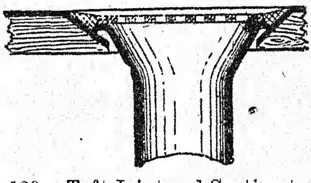
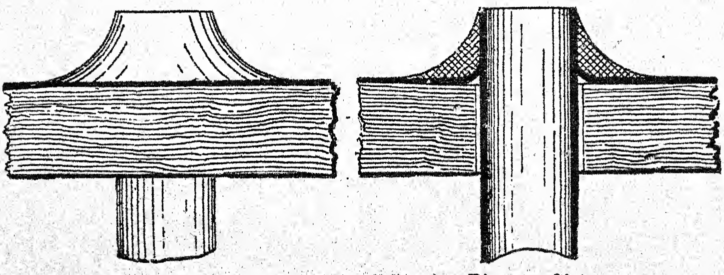


Fig. 129.—Taft Joint and Grating to Sink



Figs. 130 and 131.—Joint of Service Pipe to Cistern.

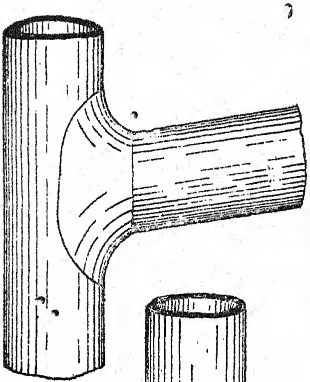


Fig. 132.

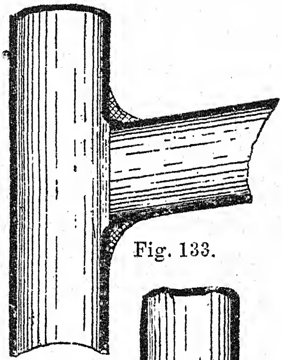


Fig. 133.

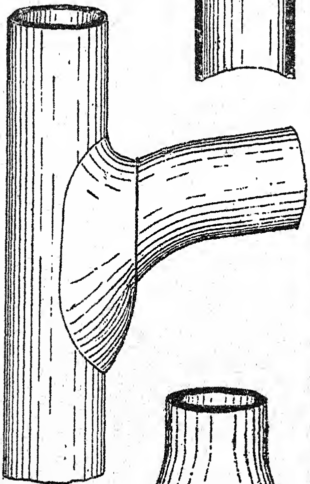


Fig. 134.

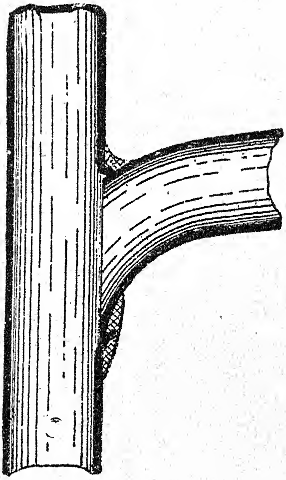


Fig. 135.

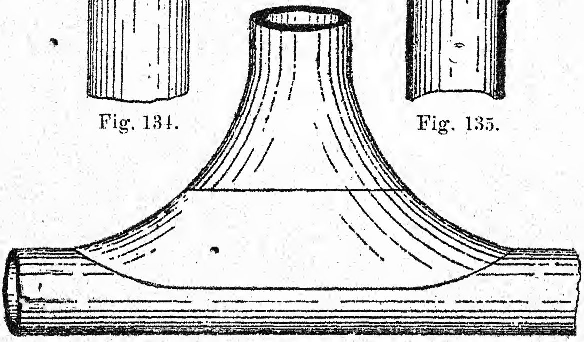


Fig. 136.

Figs. 132 and 133.—Branch Soil-pipe Joint. Figs. 134 and 135.—Branch Soil-pipe Joint with Bend. Fig. 136.—Horizontal Branch Joint to Distribute Steam Right and Left.

the back side of the bench, when the plumber again places the cloth in position and again pours, the pipe in the meantime being slowly rolled by his mate towards the wiper. As soon as the solder is at the right heat and in a plastic condition, he finishes off as described for the first method. For large joints, the pieces of pipe are mounted on a mandrel, and tightened up with thin splints forced

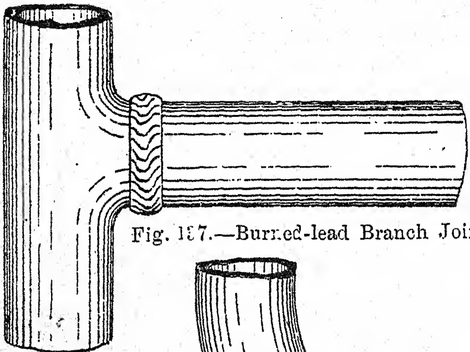


Fig. 137.—Burned-lead Branch Joint.

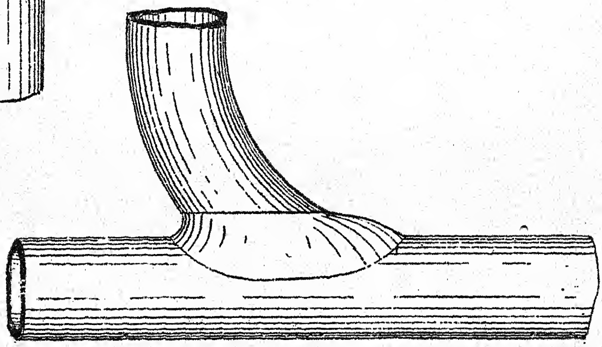


Fig. 138.—Horizontal Branch Joint in Direction of Current.

between it and the pipes, the mandrel having the ends laid in U-shaped notches cut into wood blocks and having a small winch handle for revolving during the time of wiping. Where a slow-speed lathe is handy, the mandrel and pipes can be mounted as for turning, and the joint made as above described.

Before joint wiping can be begun, a supply of soil or smudge must be prepared. This material is best when

made up in small quantities, as it deteriorates, especially in hot weather, by keeping. The ingredients sufficient for an ordinary soil pot are a penny packet of lampblack, a piece of chalk about the size of a pigeon's egg, and ¼ lb.

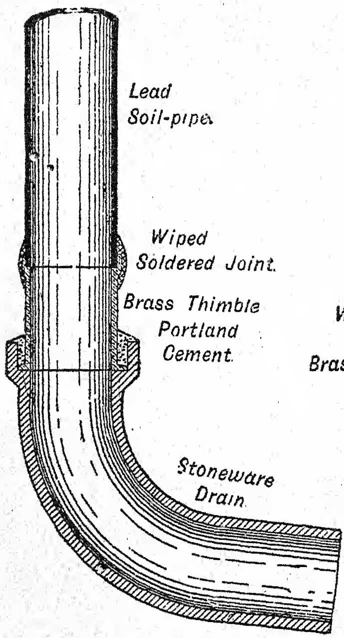



Fig. 139.—Lead Soil-pipe Jointed to Stoneware Drain.

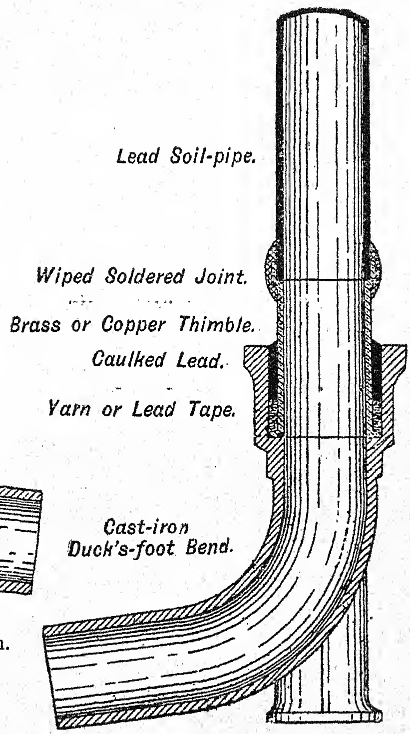



Fig. 140.—Lead Soil-pipe Jointed to Cast-iron Bend.

of size, or glue melted and diluted to the consistency of size. Some plumbers put in about a teaspoonful of brown sugar, but others object to this, as making the soil sticky. To make the soil, first put the size and a few tablespoonfuls of water into the pot, and place on the hob or by the

side of the fire to melt, but do not allow it to boil or burn. Some plumbers use small gluepots, similar to carpenters', to prevent the size burning when being heated. Next crush and grind the chalk to a very fine powder, and mix and re-grind in conjunction with the lampblack. With a pallet-knife or similar tool incorporate some of the melted size with the mixture, on a flat board or stone, to form a thin paste, after which place the whole in the pot, re-warm, and thoroughly mix by stirring. A trial of the soil should be made on a piece of lead. If, after drying, it peels off, a little water should be added; but if it is easily rubbed off, the size is not good or perhaps the lead is greasy. In the former case, use stronger size; in the latter, well chalk the lead. When old soil has become too thick by reheating, a little porter or stout can be added to make it thinner; but too much should not be used, or the soil will be so sticky that the solder will cling to it. Beer and sugar give a slightly glossy surface to the soil.

Some plumbers soil their joints, after they are made, with black japan, or thinned Brunswick black. But it is doubtful whether the effect is as good as when a "dead" black, such as given by ordinary soil, is used. If the soil is to be washed off after the soldering is done, use paper-hangers' thin paste instead of ordinary soil.

Instead of setting forth the principles of joint-wiping and leaving the application of them to the reader, it will be better to describe the process of preparing and wiping an "underhand" or horizontal joint on two pieces of, say, $\frac{3}{4}$-in. pipe.

For practice cut off with a saw two pieces of pipe each 18 in. long. The saw used by plumbers is commonly 14 in. long in the blade, and of the pattern shown in Fig. 40 (p. 19). Dress the pipes out straight with a soft wood dresser. The soft wood dresser is usually made of hornbeam, and is of the form shown in Fig. 11 (p. 18). In the shops and on jobs which are expected to take a considerable time, generally a dresser is made out of a piece of quartering, as shown in Fig. 142. It is easily made, is as useful as the design sketched in Fig. 11 (p. 18), and does not mark the pipe as a hard dresser does. It is also cheaper, as it costs nothing but the trouble of making it, the quartering being picked up on the job.

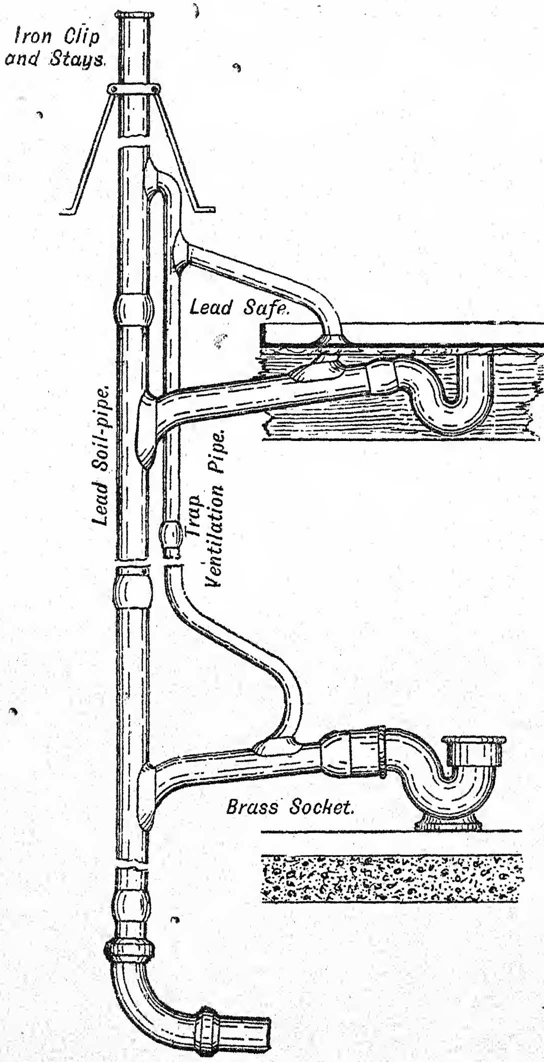



Fig. 141.—Water-closet Connections.

The pipes having been dressed out straight, square the ends with the rasp, and prove that they are true by means of a square as shown in Fig. 143. Many plumbers are very particular, when making joints, to have every pipe-end perfectly square before using the turnpin or rasping off the arris. The result is seen in the greater neatness of their work. The burr should be cleaned out of the end of one pipe, and the outer arris rasped off, as shown in section by Fig. 144. The other pipe-end should now be opened by means of the turnpin, Fig. 44 (p. 19), until the first pipe will enter as far as it is rasped off. It will then appear as in the section to the right of Fig. 144. Both pipes should now be cleaned by wiping them with a clean rag or

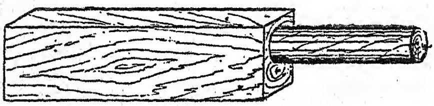


Fig. 142.—Dresser made from Quartering.

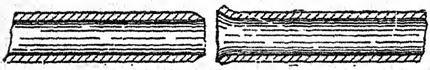


Fig. 144.—Lead Pipes Prepared for Jointing.

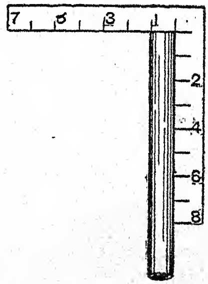



Fig. 143.—Proving Squareness of Pipe End.

glasspaper, and a little whiting or chalk rubbed on to kill the grease.

The pipes are next marked 6 in. from the end by means of a gauge (Fig. 145), the scribing points being blunted so as not to cut into the lead. The gauge is held on the pipe with one hand while the pipe is revolved with the other. The end of the pipe, up to the 6-in. mark, is then soiled—that is, painted with soil or smudge, which should have been previously warmed. If the soil "peels" off there is too much glue or size in it, or the pipe is greasy; if it "rubs" off, it is too weak in size or glue. Try the soil on a piece of lead, and add water or size as the case may be. The soil is to prevent the solder adhering where it is not

required. When the soil is dry, mark the male pipe (to the left of Fig. 144) all round $1\frac{3}{4}$ in. from the end, and the female pipe $1\frac{1}{2}$ in. from the end, by means of the gauge (Fig. 145).

Next shave, by means of a shave-hook, the parts marked. Do not dig the shave-hook too deeply into the

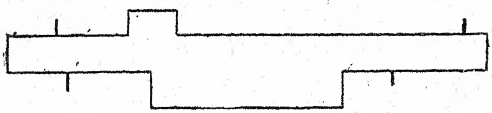


Fig. 145.—Gauge for Marking Pipes.

mark so as to gouge out the lead, but, firmly pressing the edge of the shave-hook into the mark, draw it towards the end of the pipe, leaving a bright surface. Be very careful to shave the whole of the part marked off, as an unshaved streak will cause the joint to leak, the solder not being able to adhere to any part of the lead from which the soil has not been removed, for the pipe is soiled in the first instance in order to prevent the solder from adhering

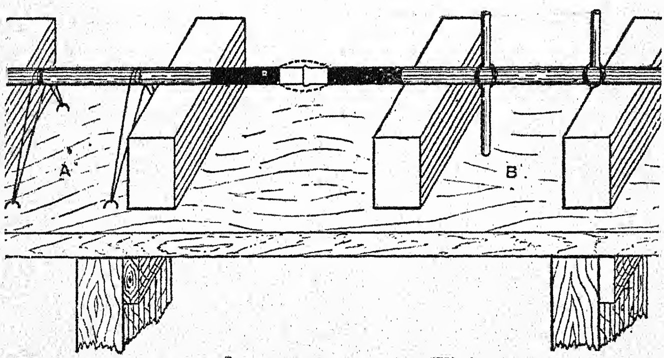



Fig. 146.—Pipes Fixed for Wiping.

beyond the limits of the joint. Shave the rasped part of the male pipe and the inside of the female pipe as far as the one enters the other. Smear with tallow the parts of the pipes which have been shaved. The tallow acts as a flux, and causes the solder to alloy with the surface of the

pipe. The solder flows in between the pipe ends and greatly strengthens the joint.

The pipes, being now prepared, must be secured in position very rigidly. They can be laid, each piece upon two bricks set on edge, or upon two short pieces of quartering, and held down on the bench by string, attached to holdfasts, as seen at A (Fig. 146), or secured to spikes driven into the bench, as illustrated at B. The width of a brick ($4\frac{1}{2}$ in.) is a convenient distance from the bench to have the pipe. If the pipe is nearer, the knuckles get burned with the solder, which drops off in getting up a heat. If the pipe is higher, the solder splashes as it falls, and burns the hands in that way. On the bench directly under the

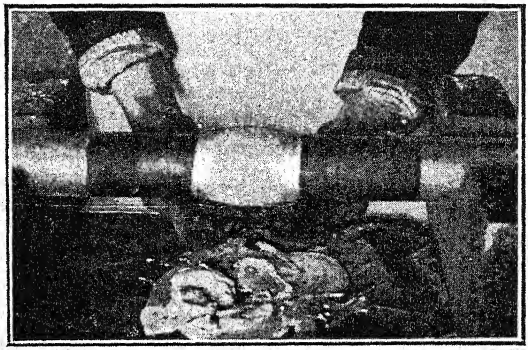


Fig. 147.—Underhand Wiping.

joint put a piece of brown paper 10 in. square and four folds thick, or better still, a piece of thin sheet iron, for the purpose of catching the solder which falls off the joint in the process of making. With a pot of solder at the proper temperature near at hand, take a $3\frac{1}{2}$-in. ladle in the right hand, and a wiping-cloth 4 in. square in the left hand, and begin. Stir up the solder in the pot so as to mix the tin, which rises to the top, with the lead, which sinks to the bottom; take a ladleful and pour it on to the pipes very slowly and carefully.

A beginner at wiping should practise forming his joints without any reference to wiping them until he can with confidence form a joint each time he tries. Then, forming

the joint quickly, he will wipe it round by keeping the cloth at the same curve all the way round and pressing on the edges so as to get them "clean" (see Figs. 147 and 148). The result will be seen in Fig. 149.

Years ago plumbers always used the iron (Fig. 23, p. 18)

Fig. 148.—Wiping Top of Joint.

when making a joint, however small. In making the joint they proceeded in the manner described above, except that when the joint was formed they only wiped the under half without the iron, and finished the upper half with the iron, using it to keep up the heat.

Fig. 149.—Wiped Joint.

For plumbers' wiping-cloths, strong cotton bedtick, when old and soft, is sometimes used, but the best material is "fustian" or "moleskin." A pair of navvy's worn-out moleskin trousers will make up a good number of wiping cloths. New can be bought at any working man's tailor's,

but such cloth has to be boiled and washed to take out the "dressing" and make it soft. The "nap," too, has to be singed, otherwise the solder clings to it. It may be scorched by passing it over a gas flame, or quickly rubbing it over a red-hot iron. The cloth requires to be well greased before using, but too much must not be used or the joints will look dirty when finished. Another objection to too much grease is the injury to the hands, the muscles of which are contracted in the palms by the steam and heat which escape when the fat is at or near boiling point in wiping joints. Plumbers make their wiping-cloths themselves according to their individual fancies as to size and thickness.

The sizes of such cloths greatly vary, according to the length of the joints and the ideas of the plumber. For an upright joint on a 3½-in. pipe the cloth would be 4½ in. long by 3 in. to 3½ wide, the thickness being 8 to 14 folds, according as the fustian is new or old, and having regard to the amount of "dressing" in it. Old is the softest and most pliable. For underhand joints a common size is 6 in. wide by 8 in. to 9 in. long. Some plumbers have them shorter, but young men burn their wrists with such cloths. Some men use a large cloth when pouring on the solder, and a smaller one, ready warmed, for wiping. The thickness for the underhand cloths is about the same as for the upright; but this is a point upon which opinions differ. The above size for upright joints will answer for either 3-in., 3½-in., or 4-in. pipes; but for underhand joints the above size can be reduced by about 1 to 2 in. in length for the 3-in. joints.

An upright joint is one of the simplest joints a plumber has to make, but it requires not only the skill in manipulation, which can only be obtained by practice, but also that patient attention to detail which is given the most readily by the workman who can render a reason for his actions.

The upright joint about to be described is made on a piece of 4-in. soil pipe, though joints of any size, from ½ in. up to 6 in. or more, can be made by the same method. Begin by straightening the pipes and squaring up the ends. Then open one end of the pipe with a turnpin, rasp off the arrises of both pipes, and see that the bore of each pipe is free from burr. The pipes should be soiled for about 6 in., leaving a clean sharp edge, which may be

obtained by carefully wrapping a piece of straight-edged paper round the pipe, and allowing the soil to overlap the paper; when the soil is dry, the paper can be removed. With a pair of compasses set at 2-in., or with a scribing gauge, scribe round the spigot pipe, and with the compasses set at $1\frac{3}{4}$ in. scribe the socket pipe. This will allow $\frac{1}{4}$ in. of one pipe to enter the other, and give a $3\frac{1}{2}$-in. joint, which is the proper size for a 4-in. pipe.

Carefully shave every part of the pipe between the scribed lines and the end, using only enough pressure to remove a very thin shaving; if any part of the pipe is left unshaved, the solder will not adhere to it; and if too much pressure is used, the pipe will be weakened at the junction of the soiling and the shaving. To keep the air from

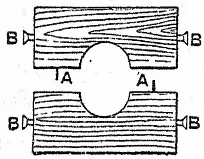



Fig. 150.

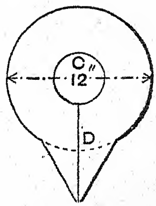



Fig. 151.

Figs. 150 and 151.—Collars for Catching Wasted Metal.

tarnishing it, and to act as a flux, rub a tallow candle (or, as it is sometimes called, a touch) over the shaved part. The pipe can now be fixed ready for wiping.

To catch the wasted metal when wiping the joint, a platform or collar will be required. To make it, procure two pieces of $\frac{3}{4}$-in. floor-board 1 ft. long, place them edge to edge, and having found the centre describe on the boards a circle, of $4\frac{1}{4}$ in. in diameter, in such a way that there shall be half a circle on each board. These half-circles should be cut out with a pad saw, and provision should be made for pinning the boards together, as shown at A in Fig. 150. Four screws should be inserted, as at B, for holding the edges of the boards together with string. The boards should be soiled all over, and they can of course be used again and again.

An alternative method of making a collar is shown in

Fig. 151, which represents a piece of sheet lead containing a circle 12 in. in diameter and a projecting tongue, C being the $4\frac{1}{4}$-in. opening, and the line D showing where the lead has been cut for convenience in encircling the pipe. Fig. 152 shows the boards in position; the lead collar is applied in the same manner. Fasten the pipes against the wall by tying them to spikes driven into the joints of the brick-

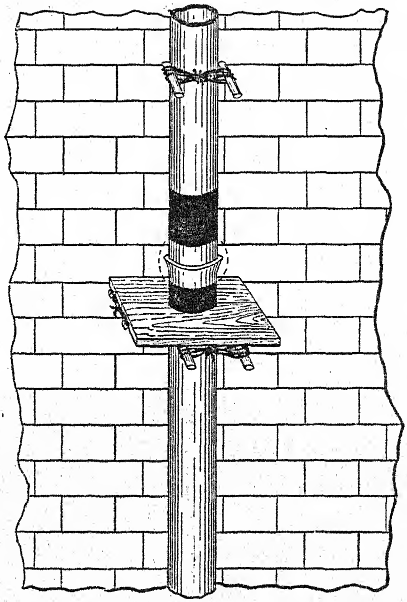


Fig. 152.—Upright Joint Ready for Wiping.

work (Fig. 152). Fig. 153 shows the pipes ready for fitting; care should be taken to ensure perfect contact, otherwise the solder will run down and form "tear-drops" inside the pipe.

In learning to wipe a soldered pipe joint (see Fig. 154), it is very much better to proceed by stages than to try to wipe all at once. The first stage is pouring on the metal and "tinning" the joint, or causing a film of solder to alloy

with the surface of the pipe. The second stage is to form the joint of the shape required, and the third and final stage is to wipe it smooth. When the preparations already described have been made, the solder melted, and the iron

Fig. 153.—Pipes Ready for Fitting.

made hot, the joint should be splashed with the molten metal, by the aid of the splash-stick, until the pipe is hot enough and sufficient metal has accumulated on it for the cloth to be used; in judging the right temperature, experience is the surest guide. Great care is necessary in melting the metal; it is too hot when a piece of paper dipped into it bursts into flame; if the paper turns brown

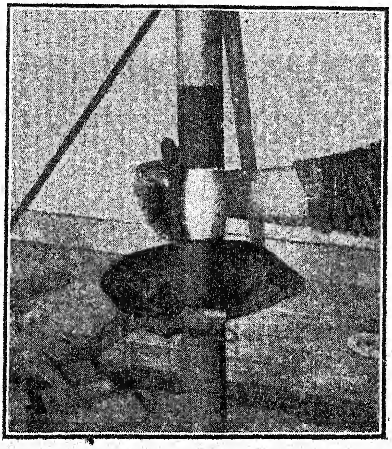


Fig. 154.—Wiping Upright Joint.

and smokes, it is at the right heat. If the surface of the paper is unchanged, the metal requires further heating. If allowed to get red hot, the solder deteriorates. The soldering-iron also should be heated to the proper temperature, and the bulb filed clean and bright. The novice

should pour the metal on to the shaved part, and on about two inches of the soiled part at each end of the joint. The cloth is held under the part being poured on, to catch the surplus solder. As the solder runs down the sides of the pipes and is caught in the cloth, it is pressed up against the bottom to help to get up the heat, and also to tin the pipes. As soon as the pipe is well tinned, the solder poured on is formed into the shape of a joint. Quickness and dexterity in using the cloth and the iron are the essentials of joint-wiping, and no amount of theoretical knowledge will compensate for their absence. The cloth used for the above joint should be folded to six thicknesses, and should measure, when folded, about $4\frac{1}{4}$ in. square. Begin at the top of the joint, and with the hot iron in one hand, and the cloth, which should be previously warmed, in the other, rub the iron over the metal on the joint and wipe round with the cloth quickly and lightly, working downwards until the joint is finished. Wipe the edges clean; ragged edges are the mark of a slovenly workman. When the joint has partially cooled, it may be cleaned and brightened by rubbing it over with tallow and wiping off with a clean soft rag. The joint will crack and sweat if it is knocked before the solder has set; the final operations, therefore, of removing the collar and re-soiling the pipe to show up the joint, should be carefully performed. All wasted metal should, of course, be collected and returned to the pot.

The amount of solder for wiping joints used by plumbers in different parts of the country varies very much. For conveying water under pressure the following weights are a fair average. The value can be found by multiplying by the price of the solder per lb.:—

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size of pipe in inches | $\frac{3}{8}$ | $\frac{1}{2}$ | $\frac{5}{8}$ | $\frac{3}{4}$ | 1 | $1\frac{1}{4}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{1}{2}$ | 3 | $3\frac{1}{2}$ | 4 |
| Solder in lbs. ... ... | $\frac{1}{2}$ | $\frac{3}{4}$ | 1 | 1 | $1\frac{1}{4}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | $2\frac{1}{4}$ | $2\frac{3}{4}$ | 3 | $3\frac{1}{2}$ | 4 | $4\frac{1}{2}$ |

Even when working on the bench, there is a certain amount of solder wasted by splashing about when wiping, and in the form of dross when melting ready for use, but when working in houses, and especially in new buildings, or when making joints in difficult positions, the waste is often found to be considerable.

Lead and composition pipes of small bore and substance can be soldered together by copper bit or blowpipe, but the wiped joint is the stronger. To make either joint, the end of one pipe is opened to receive the end of the other. The opened end is reduced in thickness, and the outer edge only is strengthened by the solder when made with a copper bit; the thinned part at the bottom of the cup or socket is not so strengthened. Hence the superiority of the wiped joint, in which the whole of the weakened parts are covered with a good thickness of solder. With service pipes, say, 2 in. or 3 in. in diameter and the lead $\frac{1}{4}$ in. or $\frac{3}{8}$ in. thick, sufficient heat could not be applied by means of a copper-bit to make a reliable joint, even when placed in a favour-

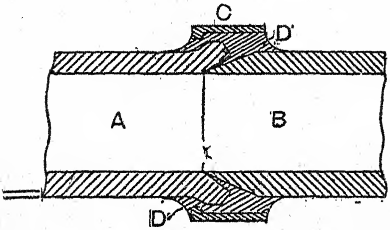



Fig. 155.—Brass Ring and Solder Joint.

able position. A leaden jack pump put together, and the suction-pipe joined on with copper-bit joints, would last but a short time. It is only the unskilful plumber who holds that the latter method is as good as wiping.

Even if the copper-bit joints were the stronger, it would be difficult to make them when the pipes are in their intended positions or when fixed horizontally. When copper-bits are used each man requires a fire or stove near him, thus adding to the risk of setting fire to the building. When wiping is the practice, one fire is sufficient for heating several pots of solder, and the fire can be in an out-building or where there would be little risk of injury.

Small joints could probably be made with the copper-bit in a little less time than wiping, but for all-round work a skilful plumber could wipe joints as fast as solder them with a bit. It is only on small jobbing works where it is

difficult to get a fire for heating a pot of solder that the bit has an advantage in time.

The wiped joint is rather difficult to make well and neatly, except by first-class workmen. The form of joint illustrated in Fig. 155 can, however, be made by any fairly competent workman, and gives a good joint with a very small amount of solder. A and B are the two ends of lead pipes to be joined; C is a turned ring of brass, steel, or other suitable metal that cannot be fused by solder; D is

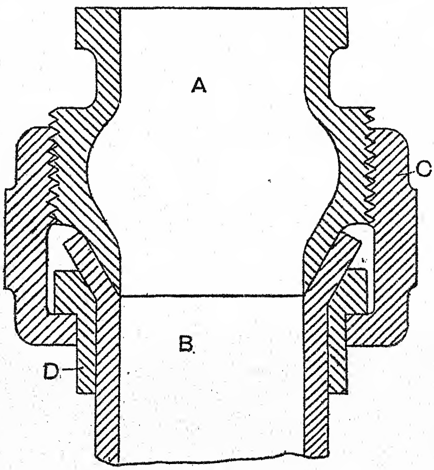


Fig. 156.—Lead Pipe Screw Coupling.

the solder filling up the space between the lead pipes and the ring. Such joints have been carefully tested, and found to withstand a greater pressure than the pipe itself. A joint of this type for a 1-in. pipe requires only 1 oz. of solder, whereas a wiped joint would require 20 oz. The essential part of the joint is the brass ring C, which forms a support for the solder D, and reduces the workman's task merely to wiping off the superfluous metal.

Many methods have been adopted for coupling lead pipes to pumps and other machinery, but as all these methods possess certain features in common, only one

example need be illustrated. This is shown in Fig. 156. In this case A is a casting to which the lead pipe B has to be connected. The casting is screwed on the outside and fitted with a nut, C. D is a bush placed over the pipe B and inside the nut C. The outside of the casting A is

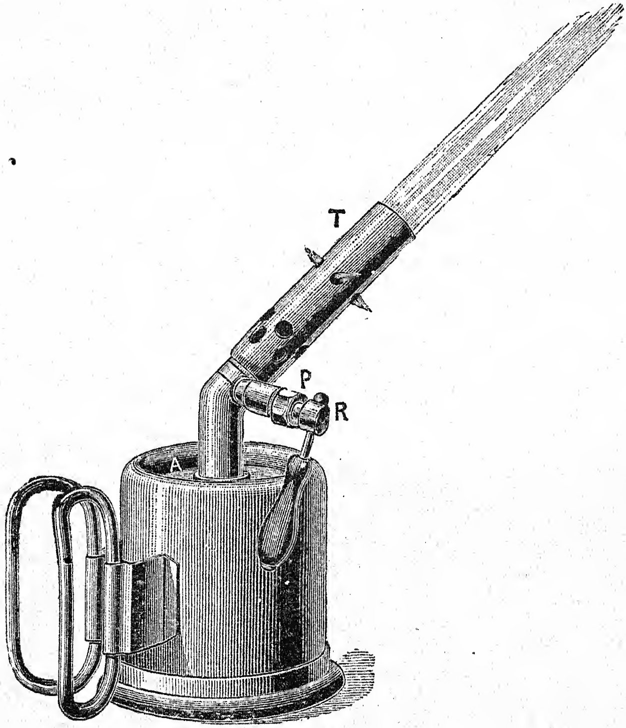



Fig. 157.—Plumber's Soldering Lamp.

coned at the end to fit the inside of the bush D, so that when the nut is tightened the lead pipe is coned and a tight joint effected.

For wiping a joint, using a splash-stick and a soldering iron, take a ladleful of metal, and with the splash-stick splash the solder on to the joint and soiling to get up the heat (the iron should be heating at the same time). When

the pipes are sufficiently heated and there is enough solder on them to form the joint, take the iron, heated to a dull red, and rub it with a file to take off the dirt and

Fig. 158.—Socket on Lead Pipe.

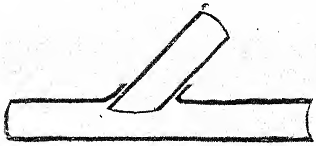


Fig. 159.—Badly-made Branch Joint.

Fig. 160.—Bolt-pin or Tommy.

scale; then rub the iron all over the solder on the joint, and wipe as before.

It is very handy at times to be able to make a joint without the use of metal-pot or iron, and this can easily

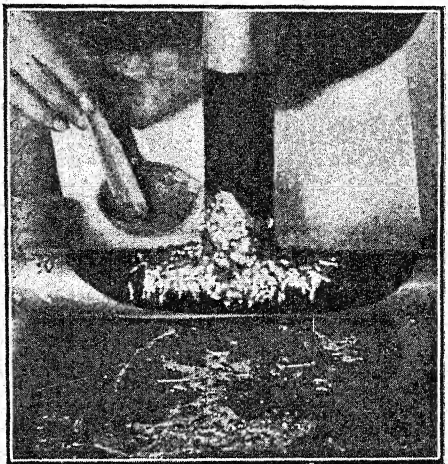


Fig. 161.—Wiping Branch Joint.

be done with a good blowlamp. To make the joint, take a strip of plumbers' solder run out about 15 in. or 16 in. long, and with the lamp warm up the joint (previously prepared as for wiping in the ordinary way); then melt off portions of the solder, and keep the soft solder more or

less in shape with the stick. Do not keep the lamp right on it full blast, but if the metal runs too fast and drops off, withdraw it a little or check the flame with the regulator. Having got sufficient solder on the joint and roughly shaped it, promptly pick up the cloth and wipe as before. A plumber's soldering and brazing lamp is shown by Fig. 157.

A branch joint (shown by Fig. 136, p. 59) is prepared by cutting a hole in one pipe somewhat smaller than the pipe that is to enter it, and working it up to a kind of

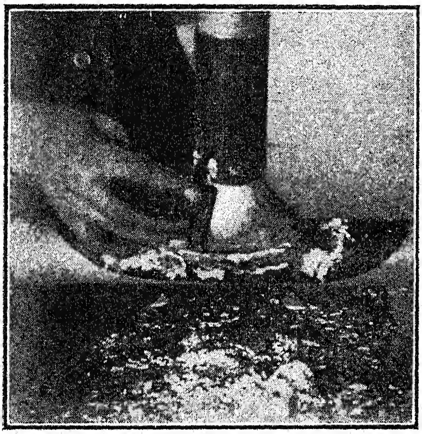


Fig. 162.—Wiping Branch Joint.

socket, as shown by Fig. 158. The entering pipe should never project into the other pipe further than the depth of this socket, or it would, in the case of waste or soil-pipe, cause obstructions. Fig. 159 shows a section of a badly-fitted branch joint, the proper way being shown by Figs. 133 and 135 (p. 59). The socket is worked up by means of the bolt-pin, or tommy (Fig. 160), which is inserted in the hole and struck with a hammer. Great care must be taken in fitting branch joints that they fit perfectly close, or the solder will run through. The wiping process (see Figs. 161 to 163) will be similar to that already described.

Taft joints (Figs. 121 and 122, p. 57) are not much in favour with skilled plumbers. They are much decried by some, but if properly constructed they are a strong, useful joint. The method of operation is to taft back the edge of the lower pipe from 1 in. to $1\frac{1}{4}$ in., according to the size of the pipe, and here is where many spoil the joint. A and B (Fig. 164) respectively show bad and good tafting; at A the pipe is shown flanged back quite sharp and square. It is thus rendered very weak at the angle, where it is liable to break off should there be any weight

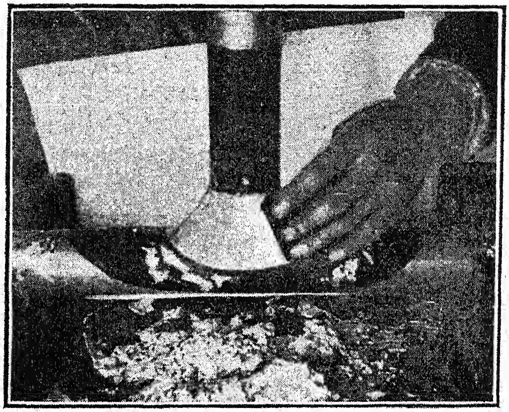


Fig. 163.—Wiping Branch Joint.

or expansion and contraction of the pipe; but if made with an easy curve, as shown at B (Fig. 164), the joint when completed (see Fig. 122, p. 57) is a very good one. It is probably the easiest of all wiped joints to make. After tafting back the pipe, shave the inside, soil the top pipe 4 or 5 in., and shave the end $1\frac{1}{4}$ in.; place in position, "touch" round, and either pour or splash on the solder, and when sufficiently plastic wipe as before described.

The flange joint may be of either of the forms shown by Figs. 115 (p. 56) and 165. It is used mostly where a small pipe comes through a floor. To make the form shown by Fig. 165, first cut a lead collar or flange 3 in. or 4 in. larger

in diameter than the pipe that is to pass through it; cut a hole the exact size of the pipe, and slip it over it, then cut the pipe off so that it stands up $\frac{3}{4}$ in. or 1 in. above the flange. This is best done with a tenon saw and piece of board the thickness of the stand-up desired. Next drive the turnpin in to swell the pipe out a little, and then work the pipe down on the collar; prepare and make the joint as described for the taft joint. In Fig. 165, A represents the floor, B the lead collar or flange, C the lower pipe, D the upper pipe, and the dotted lines the wiped soldering. To make the form of joint shown by Fig. 115 (p. 56) the instructions given in the previous paragraph will largely apply.

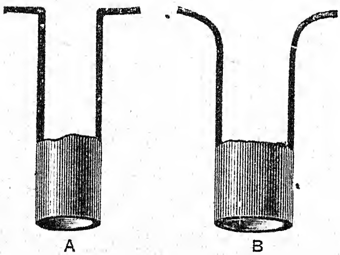



Fig. 164.—Bad and Good Taft Joints.

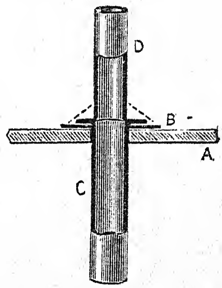



Fig. 165.—Section of Flange Joint.

The block flange joint (Fig. 124, p. 57) is stronger than the plain flange joint. The wood block through which the pipe passes is fixed in the wall to support the pipe. This block is dished out as shown, and the lead flange, with a hole cut in it, that will just admit the pipe, is dressed down into it; the pipe is then passed up through the block and flange, and the turnpin driven in as previously mentioned to open out the pipe. Now, instead of dressing it sharply back on the flange, it is left as shown in the sectional view (Fig. 124), so that the solder will run underneath as wel as above the tafting, thus forming a very strong substantial point. Of course it will be noted that the outside of the pipe that is tafted back will require to be shaved and "touched" as well as the inner part. It

is also advisable to tin the lead flange before putting in place, to ensure more perfect cohesion between the parts. This class of joint is mostly used when soil or vent pipes are fixed in the interior of dwellings, in a chase or cutting left in the wall for that purpose.

An astragal joint is shown in elevation and section by Figs. 125 and 126 (p. 58), and it consists of a soldered joint with ornamental mouldings, or astragals, round the pipe. For the astragals, a pattern of the design is first made in wood, and from this a print is made in damp, loamy soil, in which molten lead is poured to form a casting. If many are required, the wood pattern should be sent to a foundry, and a flask made in gun-metal, from which any number can be cast. These do not require so much cleaning up to make them look smart as those cast in sand. For fixing them to the lead soil pipes the back sides are tinned with a copper bit, and also corresponding parts on the pipes. The astragals are then folded about three parts round the pipe, and 9 in. apart, and "sweated" on by means of a blowpipe. If this is neatly done, no solder will be visible.

The tack (the plain flat part shown in Figs. 125 and 126) should be cut out of 8-lb. sheet lead, about 9 in. square, the edges trued and trimmed, one end soiled 3 in. and shaved 1 in. wide; corresponding spaces for a pair of tacks, prepared on the soil pipe, between the astragals and soldered seams, are then wiped or floated with metal and a plumber's iron. Cast-lead tacks have an advantage, as the nail holes are strengthened by having an extra thickness of the metal round them. A cast tack and pipe are shown in elevation and horizontal section by Fig. 166; a folding tack and pipe are similarly shown by Fig. 167, and a soldered face tack and pipe by Fig. 168. The letters in Figs. 166 to 168 merely indicate the line of section.

Expansion joints are of many kinds. An ordinary one is similar to a slip joint, but an indiarubber or asbestos ring is used instead of any packing or jointing material which would become hard. The first-named joint is generally used on outside lead soil pipes, and the latter two for waste pipes, but chiefly for those through which hot water passes.

Although a lead pipe can be wiped to a cast-iron pipe

with a fair amount of ease, the joint will not stand satisfactorily. The best way is to file clean the end of the cast-iron pipe and then coat it with pure tin, using sal-ammoniac as a flux. The pipe is then washed to remove the sal-ammoniac, and afterwards re-tinned, using resin and grease as a flux. A plumber's joint ($3\frac{1}{2}$ in. long for 4 in. pipes) is then wiped in the usual way. Great pains will now have been taken to make a good, sound, strong joint

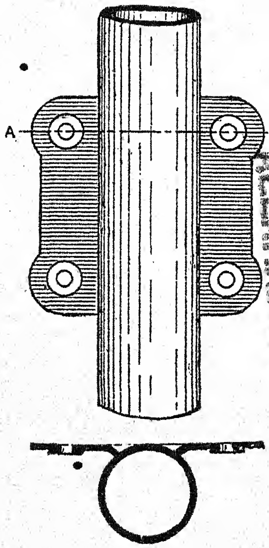



Fig. 166.—Elevation and Section of Cast Tack and Pipe.



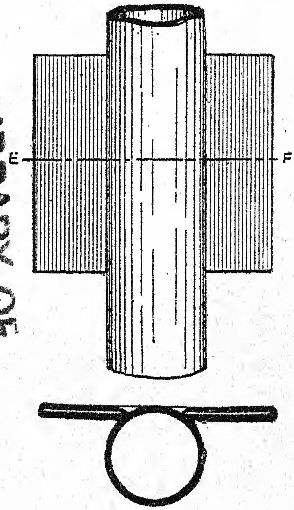



Fig. 167.—Elevation and Section of Folding Tack and Pipe.

between the two metals. Nevertheless, in the course of time (it may be only a few years) the iron will come out of the solder. The first sign of decay will be a red ring of iron rust showing at the end of the joint. This rust will swell a little and cause the end of the soldering slightly to curl outwards. Eventually the rust will creep between the solder and the iron and destroy the adhesion of the one to the other. Only those metals that alloy together can be satisfactorily joined by soft soldering, and the solder

should contain as great a proportion as possible of the metals that are to be united. The joint would, if out of doors, be subjected to temperatures ranging over 90° F.; under such conditions the solder would expand ·001251 in., and the iron would expand ·000549 in., or less than half as much as the solder. The joint would therefore eventually become a loose ring on the iron pipe, but not on the lead pipe, as the expansion of lead and solder do not differ much.

Numerous experiments have been tried for overcoming the difficulty of wiping joints on ordinary tin-lined pipes, but the only method which has been found to approach success has been to insert a long nipple of tinned sheet iron; this method, however, has not been wholly successful with the ordinary make of tinned pipe. However, on a new kind of tin-lined pipe, wiped joints can be made very easily, without the tin lining melting.

It would often be a convenience if copper pipes could be united satisfactorily by wiping, but plumbers' wiped joints are of no use with copper tube, for the expansion and contraction will not permit them to remain sound, as many hot-water engineers know to their cost; brazed joints would be satisfactory, though troublesome to make. If copper pipe is thick enough to be threaded, have the fittings threaded also, and screw them together the same as with iron pipe, except that with long runs there must be expansion joints or other provision made for expansion. Even when a wiped joint on copper pipes is strongly made by "sweating" on a sleeve and then wiping a joint over the whole, it is doubtful if it would be permanent. It is very probable that electrolysis would set in, if the pipe is in damp ground. However, should circumstances suggest that a wiped joint might answer, the work is done as described below.

Wiped joints on copper pipes are longer than wiped joints on lead or composition pipes. Copper pipes 2 in. or more in diameter have joints from 3½ in. to 4 in. long, 4-in. pipes have joints about 5 in. long; but it must be remembered that whilst reasonable length and thickness of joint are necessary to enable the copper pipe to withstand pressure and strain, the maximum time of service does not depend on the length or thickness of the joint as in lead-

pipe work. That which determines practically the life of the joint is the extent of pipe which is carefully tinned before making the wiped joint. If the interiors of the two pipe ends are tinned, say, for 6 in. to 8 in., if the joint is cut open, in a few years' time, it is found that the tinning has diminished to 2 in. or 3 in., a corroding action having taken place at the end of the tinning; for this reason it is advisable that the tinning be fairly thick, so as to retard the separation and ultimate failure of the joint. In tinning copper, first thoroughly clean it with dilute sulphuric acid

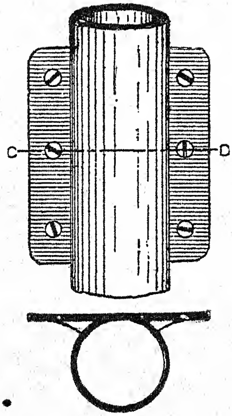



Fig. 168.—Soldered Face Tack and Pipe.

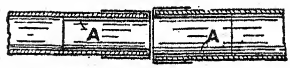



Fig. 169.—Copper Pipes Prepared for Jointing.

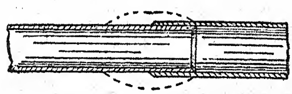


Fig. 170.—Wiped Joint on Copper Pipes.

or scour with sand and water, and then rinse it with chloride of zinc, known as killed spirits. Melt some pure tin, throw in sal-ammoniac as a flux, and dip the copper in the tin, or pour or rub the latter over the copper. In pipes forming a portion of a distillery plant it is especially important that untinned spots are not left on the interiors of the pipe ends, as at such spots the destruction of the tinning commences at once. In Fig. 169, which is a part sectional view of the two pipe ends prepared for jointing, A shows the extent of the tinning, which is on the exterior and interior of the pipe ends and on the edges also. Fig. 170 shows the tinned ends slipped together ready for

wiping, the form of the required joint being shown by the dotted lines. The pipe is strengthened by putting one pipe within the other, and the corrosion of the tinning is arrested when it reaches the lap. If sufficient lap is given, the pipe may be handled before the joint is wiped—a great convenience. The pipe ends are placed together, when practicable, over the iron pot containing the molten solder, which is then poured continuously over the joint until a heat is got up. This practice is not possible with lead or brass pipes, because in the one case the lead would melt, and in the other the molten zinc would leave the brass and ruin the solder. When the pipes cannot be moved, a grain scoop (a kind of shovel) is placed beneath the joint and the solder poured on rapidly. When a thorough heat has been obtained, the joint can be wiped, with the aid of a cloth and of the mushy solder from the scoop, in much the same way as a joint on a lead pipe is wiped.

Plumbers are constantly called upon to make soldered joints in small-bore composition pipes used for conveying gas or water. The soldering of compo pipes is best done with a blowlamp; this is the general practice, the copper-bit being used only for tinning, though it can of course be used for making any joints required in gasfitting. A tool that simplifies joint-making is shown in Fig. 171. It consists of two pieces of sheet copper soldered into the form of cones, and then joined together. A similar tool, made of sheet iron with a cutting edge, can be purchased ready made, but it thins the pipe too much; the tool shown in Fig. 171 can be made in an hour, and answers its purpose perfectly.

The joint shown in Fig. 172 is called a copperbit joint, and to make it the pointed end of the bit is inserted in the pipe and pressed down, and at the same time turned round, thereby opening the pipe. The end of the other piece of pipe is contracted or tapered, and is firmly pressed with a screw motion into the open end of the first piece of pipe, and it will be found that they are held well together, and that a practically tight joint is made before soldering.

When ready for soldering, slightly open the socket pipe end with a turn-pin, to form a bed for the solder, and, after scraping the parts clean, rub the joint with tallow and press the pipes firmly together. Having placed a tin con-

taining crushed resin within easy reach, light the lamp, take a stick of fine solder in the right hand and the blow-lamp in the left, and blow a flame round the joint (taking care not to keep the flame long in one place or the pipe will melt), hold the end of the solder in the flame until hot, dip it in the resin and rub round the joint. When the pipe is hot enough to melt the solder, cease blowing, and press the solder all round the joint, with a dotting motion, using the lamp as required. When enough solder to form the joint has been deposited on the pipe, the solder is made to flow by again heating; it will then form a collar as shown in the illustration. Cease blowing directly there is any sign of the pipe melting, and avoid having too much solder on the joint, or it will run down over the ledge left

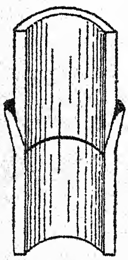


Fig. 172.—Copper-bit Joint.

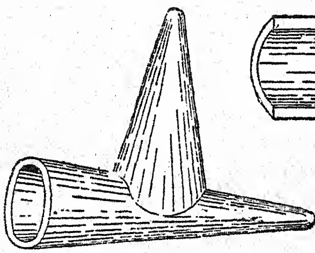


Fig. 171.—Tool for Making Joints.

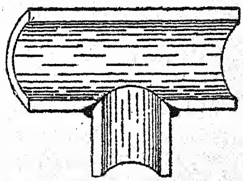


Fig. 173.—Branch Joint in Composition Pipes.

to hold it and disfigure the joint. The resin is removed by rubbing round the joint with tallow and wiping off with clean rag, but be sure the joint is set before disturbing it.

A branch joint (Fig. 173) is made by running a file across the pipe to remove part of the metal, and then with a brewer's gimlet or a knife making an opening, say $\frac{1}{8}$ in. less than the diameter of the pipe to be inserted; a piece of round wood, tapered, that just enters this hole is inserted with a screwing motion that slightly burrs up the sides of the hole and makes it circular, ensuring a perfect fit with the spigot pipe. Slightly contract the end of the pipe to be fitted, as in making the copperbit joint, and insert it in position with a gentle pressure until a tight fit is obtained. Scribe round at the junction, take out and cut off the end

of the pipe to $\frac{1}{8}$ in. of the scribed line, run the round file across the opening to form a seat for the solder, cut away any projections from the inside of each pipe, then rub with tallow, and press the pipes together and solder. In making a branch joint at the side when it is impossible to get underneath with the lamp, the solder is put on at the sides, and when heated carefully can be made to flow underneath. A bit of looking-glass held under the joint will show if the joint is a good one.

Before brass or copper fittings can be soldered to compo, the end that requires fixing must be tinned—that is, covered with a coating of solder. The usual fittings are to be bought ready tinned, but it is the usual practice to re-tin them, as the coating given by the manufacturer is generally insufficient to make a good joint. The end to be tinned is filed perfectly clean, care being taken that no part is missed or the solder will not adhere. Have ready a well-heated copperbit and a supply of fine solder; some powdered resin is sprinkled on the brass and the copperbit and solder immediately rubbed on it, more resin or solder being added as necessary; when it is well covered with solder, finish by drawing any drops of solder from the end of the brass towards the opposite end, because any globules or drops of solder left on the brass will, when it is placed inside the compo pipe and heat applied, melt and run down inside the pipe, making it difficult to secure a proper joint. The end of the compo pipe is then opened out to admit the brass, which is pressed firmly into the pipe, the flame of the lamp being directed chiefly on the brass. As brass is a good conductor of heat, it is necessary in tinning small fittings to hold them with a pair of pliers, or to adopt some such contrivance as a piece of wood driven into the brass and used as a handle; by the latter method much better control is obtained than by using pliers.

# CHAPTER VI.

## LEAD-BURNING.

THE art of lead-burning, although very properly allied to the plumbing trade, was not generally recognised until quite recently as being part of the plumber's craft. It is, however, a most useful acquisition, and the introduction of lead-burning tests into the Practical Examinations in Plumbers' Work of the City and Guilds of London Institute renders it imperative that the student should be well acquainted with both the theory and the practice.

The term lead-burning, although generally accepted and understood, is not strictly accurate, as the lead or metal is not really burned, but is fused. The process is also sometimes referred to as autogenous soldering. This term is also incorrect, as solder is not used in connection with lead-burning; however, a strip of pure lead is applied in much the same way as a stick of solder is in the ordinary process of soft-soldering. Briefly, lead-burning is a process by which two pieces of lead may be joined by fusion. The credit of the invention of lead-burning is due to a Frenchman, who in 1838 found that by a combination of hydrogen and oxygen a flame could be produced that would unite certain metals which melt at comparatively low temperatures, and especially lead and tin.

Although a very useful process, and one easily acquired, very few plumbers know how to do lead-burning, and the few who have the necessary knowledge and practice endeavour to keep it to themselves as much as possible, so that others who know little about it regard lead-burning as a very dangerous operation, and content themselves with soldering or brazing any piece of work which may require connecting.

There are two methods of lead-burning. In the first the junctures of the two sheets of metal are scraped clean and bright, the joint bedded in sand so as to form a channel from end to end, each side of the channel is soiled to prevent adhesion of lead, and lead heated above its melting

point is poured along the channel until the lead junctures fuse together. The surplus lead is then shaved off. In the second method a blowpipe is employed, and the flame is fed with hydrogen gas generated in a vessel on the spot. A foot-blower is employed to force a stream of atmospheric air into a stream of hydrogen gas, and the jet of flame is directed on to the cleaned joint, and this flame melts the lead as it is moved along the juncture. It is this second system that is generally meant when the term "lead-burning" is used.

This system of joining metals has many advantages over soldering. The difficulty of making joints where pure tin has to be dealt with is entirely overcome by burning. For lining tanks for chemical purposes, or making chemical apparatus, where solder would be quickly destroyed, lead-burning is the only method which can be adopted; for joining seams or pipes for lining stone tanks where wiping is extremely difficult, or sinks to which hot water is laid on, it can also be successfully employed.

An advantage of lead-burning over soldering is that only one metal is used, and corrosion by electrolysis, or voltaic action, does not take place as when another metal, such as tin in solder, is in contact in a wet position. The only circumstances in plumbers' work in which burning must be insisted upon are in chemical works or manufactories where chemical acids are used. The pipes, tanks, acid chambers, etc., have to be made of lead, which should be as pure as possible, free from alloys of other metals (excepting when hardened by antimony for special purposes, such as acid pumps), and joined together without the aid of solders of any kind.

Lead-burning is extensively employed in the fitting up of a chemical plant, in which wood and stone tanks must be lined with sheet lead, while lead-piping is largely used. All seams and joints in connection with this work must be burned, as not only is solder subject to chemical action, but where heat is applied the unequal expansion and contraction would quickly break the joints or seams. Laboratory fittings, such as sinks, trays, benches, etc., which are generally covered or lined with lead, and the various appliances in connection with chemical experiments, all have to be burned where a joint or seam is necessary.

In connection with domestic plumbing arrangements the burning process may be used to advantage in making the seams on lead soil-pipes, for the fixing on of astragals, etc. An upright joint on the face of a building is difficult to make; and when the pipe is exposed to the direct rays of the sun, the life of a burned joint would be very considerably longer than that of a wiped joint. The joint can be made in any position, and damage to the building through the cutting of brickwork or the fixing of special arrangements necessary for joint wiping is of course entirely avoided. An extra branch may be put in without disturbing the stack. The only disadvantage in this connection is that a brass ferrule cannot be fixed to a lead pipe by this process, but in connecting a metallo-ceramic joint such as Doulton's to a lead soil-pipe, the process may be usefully employed. In the lining of sinks and trays with lead the seams are easily and securely made, and there is equal expansion and contraction of the metal throughout.

Lead-burning apparatus consists of an appliance by which hydrogen gas can be freely generated, and a machine by which air can be forced along, also a quantity of rubber tube, and a junction piece and jet.

Hydrogen may be produced in many ways, but the method most in favour is by the action of diluted sulphuric acid on zinc. When these two substances are brought into contact with each other, the sulphuric acid is split up, forming zinc sulphate and giving off hydrogen, thus:—$Zn + H_2SO_4 = ZnSO_4 + H_2$. Hydrogen is the lightest substance known, and is colourless, invisible, and inodorous. It is taken as a standard by which all other gases are compared for weight. When in free combination with atmospheric air, it forms a highly explosive mixture, and this fact must be borne in mind when the lead-burning apparatus is being used. If due care is exercised, there need be no uneasiness on the part of the operator; but he should not hold a light over or near the generating machine, nor should he attempt to light the outlet tap in order to ascertain whether or not hydrogen is being produced.

The old type of lead-burning machine consisted of an open cylinder, from 3 ft. to 4 ft. high, and about 1 ft. in

diameter, holding the acid and lined with lead. A closed vessel known as an ometer, containing the zinc, was immersed in the cylinder, and a pipe from the top of the ometer carried off the gas (see Fig. 174). This was a simple appliance, easily cleaned and charged, but its disadvantage lay in the fact that if gas was generated in larger volume than was required by the operator, it was wasted; and the ometer, when not in use, had to be lifted out of the cylinder, and when again immersed occupied some little time before it was ready for use. The air was generally supplied from a circular bellows encased in an iron frame and worked by an assistant. The arrangement is shown in Fig. 175.

The actual dimensions of the old-type machine shown by Fig. 174 are 3 ft. high and 14 in. in diameter. There are two cases, or chambers, the outer one being usually a cylindrical vessel, lined with lead; this is half filled with a mixture of sulphuric acid and water—about a quart of acid to two gallons of water. The chamber D is an enclosed lead vessel, with a pipe leading from the top, and a loose lead bottom which can be taken out when required. Into this receptacle is placed from 4 lb. to 6 lb. of zinc spelter; and, when it is immersed in the dilute acid, the liquid finds its way among the zinc through perforations in the bottom of the inside case, and chemical action is set up, hydrogen gas being generated. This, when the tap C is turned on, is conveyed along a rubber tube to a junction, where it is mixed with air, forced along from the bellows (Fig. 175) and carried to the jet, which is a small brass tube with a cap screwed on the end. In this cap is a small hole, through which the gas is emitted, and when a light is applied to it a long, thin jet of flame is produced, which gives little or no light, but an intense heat, and when the flame is applied to the surface of metal it readily fuses it. Should such a machine come into the hands of the reader, it should be operated as follows:—When the machine is charged with the acid, water, and zinc, and the ometer is immersed, open the tap at the top and let out the air. Then close it, and allow the machine to stand for a short time, until the acid has begun to act on the zinc. Meanwhile connect the pipes to the tap and the bellows, and then, whilst an assistant operates the bellows, the

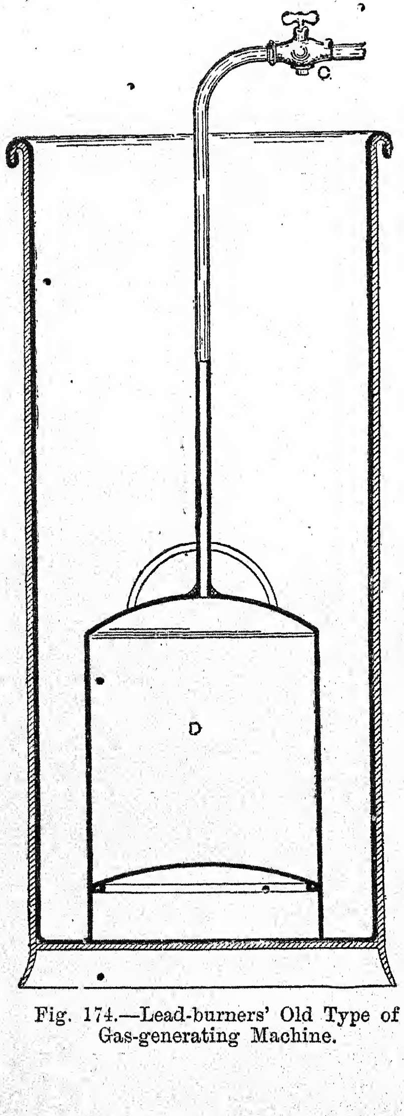



Fig. 174.—Lead-burners' Old Type of Gas-generating Machine.

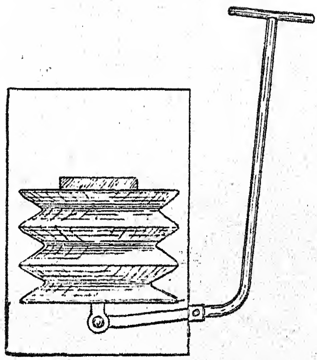


Fig. 175.—Hand Bellows

gas may be turned on. When the flame is adjusted, apply the jet of flame to the prepared seam in the manner explained later in the chapter. The hottest part of the flame is the centre of the thickest portion, usually about 1 in. from the cap. Proficiency will be attained after a little practice.

A complete machine for lead-burning can be made simply and easily if the following directions are observed. Illustrations of the machine are shown in diagram form so that the construction of the machine may be the more

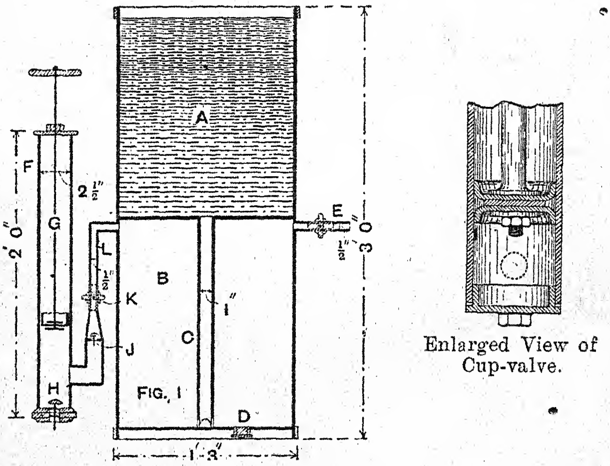



Fig. 176.—Air Chamber of Lead-burning Machine.

easily understood. The air chamber (Fig. 176) supplies a current of air and the device (Fig. 177) supplies the hydrogen gas; tubes from the two chambers are connected to the breeches piece or junction piece (Fig. 178), the air and gas mix, and are burnt at the jet V shown in Fig. 178.

The cylinder shown in Fig. 176 is made of No. 15 zinc, and is divided into two equal parts A and B. From the bottom of the chamber A a lead or zinc pipe C extends to the bottom of the chamber B. This pipe rests on the bottom, but has three or four semicircular pieces cut out of its end. D is a cleansing screw to give access to B, and E

is a stop-tap leading from the air chamber B. F is a brass air pump, and G is an iron rod fitted with a handle and having at its lower end a leather cup-valve shown enlarged attached by means of two circular plates. H and J are valves which open upwards, K is a stop-tap, and L is a pipe leading to the chamber B. When a supply of air is required, the lower half of the cylinder is filled with water. The stop-tap K is then opened and air forced in by means of a pump. This forces the water, through the pipe C, from the chamber B to the upper chamber A. The stop-

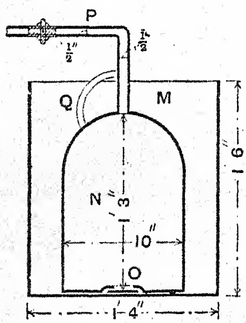



Fig. 177.—Gas-generator of Lead-burning Machine.

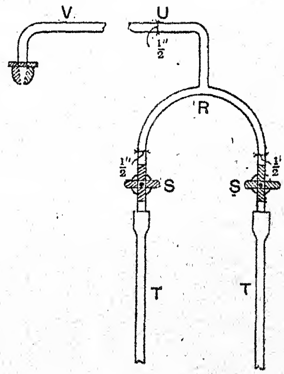



Fig. 178.—Breeches Piece.

tap K is then closed, and when the supply of air is wanted the stop-tap E is opened.

The gas-making apparatus shown at Fig. 177 consists of two vessels M and N made out of 6-lb. lead; M is an acid chamber, and N the chamber in which the gas is generated. O is an opening in the bottom of N to enable zinc to be placed in it. This opening is covered by a flap made out of a piece of lead, the lead being soldered along one edge. P is the outlet pipe for the gas, and is cut from a ½-in. 7-lb. lead pipe; it is provided with a ½-in. gas stop-tap at the end. At Q is shown a handle made from ½-in. 7-lb. lead pipe.

To manufacture the gas, zinc clippings are put in the chamber N, which is then placed inside M; this latter

chamber is filled with dilute sulphuric acid in the proportion of 1 part of acid to 8 parts of clean water. The acid should be added to the water slowly, and stirred all the while. A chemical action takes place between the acid and the zinc, the result being that hydrogen gas is evolved, as explained on p. 89.

In Fig. 178, R is a brass breeches or junction pipe provided with two stop-taps S S for regulating the supply of gas and air. T T are rubber tubes, one of which is connected to E (Fig. 176) and the other to P (Fig. 177). U (Fig. 178) is a brass pipe leading from the breeches pipe R, the burner V being connected to it with 3 ft. or 4 ft. of rubber tube, so that the operator can move the burner as may be convenient to suit his work.

To set the machine in operation, the lower half of the cylinder (Fig. 176) is filled with water, the stop-tap K is opened, and air is forced in by the air pump pressing the water into the upper half of the cylinder. The stop-tap K is then closed, leaving the lower half of the cylinder filled with air that is compressed by the weight of the water in the chamber A. The zinc is placed into N (Fig. 177), and the chamber placed into M, which is then charged with dilute sulphuric acid. The stop-tap P is opened to allow the air in the chamber B to escape, and the gas takes its place. The rubber tubes are then slipped on, and the burning is begun. Should the pressure of the gas in the chamber N become too great, it may force the acid out of chamber M (Fig. 177); the operator should therefore be careful to stand clear, and not get over these chambers when they are charged.

Coal-gas may be used for lead-burning in combination with oxygen under pressure, as used for limelight. This is very convenient for a small job, all that is required being a tube to connect to the gas fittings and a steel cylinder containing oxygen, which is made by Brin's Oxygen Company and may be procured in most towns, or oxygen which can be easily carried about.

The lead-burning apparatus illustrated by Figs. 179 to 191 may be used for all ordinary work, and when properly attended to will give excellent results. Undoubtedly it is the best of those described here. The gas generating machine is illustrated by Figs. 179 to 182, and it is made

up of a sheet-iron outer casing, strongly made, with riveted seam, as shown in Fig. 183, and with handles at-

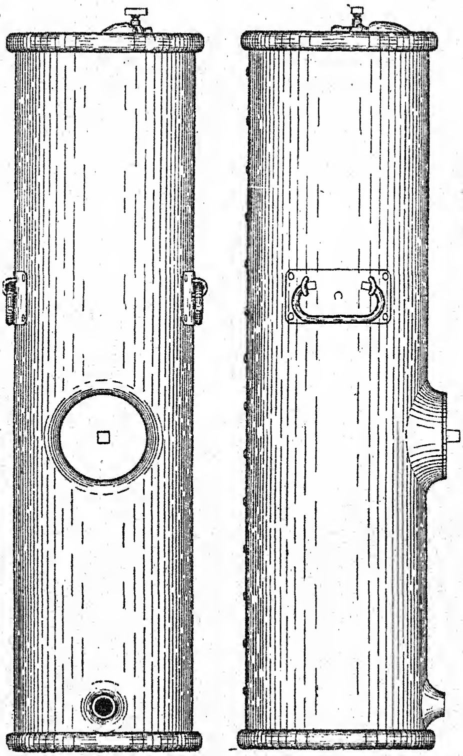


Fig. 179. Fig. 180.

Figs. 179 and 180.—Front and Side Elevations of Hydrogen Generator.



tached. A stout rim is formed on the top and bottom, as shown, and the machine generally must be not only portable, but capable of withstanding rough usage. Through a hand-hole A (see also Fig. 184) in the side the zinc or spelter is put into the lower chamber, and another hole

near the bottom is for running off the spent liquid and for cleaning out.

The internal construction is entirely of lead. The

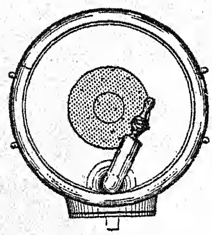


Fig. 181.—Plan of Hydrogen Generator.

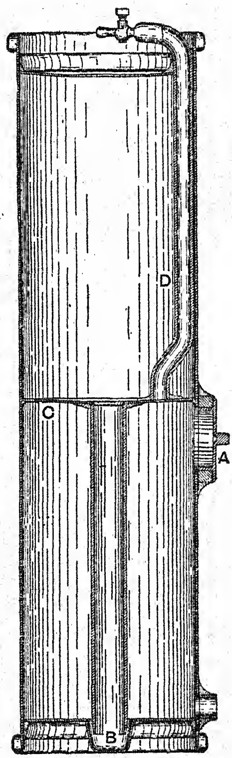



Fig. 182.—Section of Hydrogen Generator.

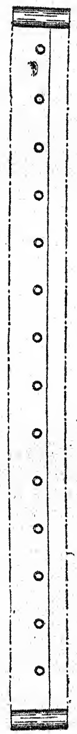
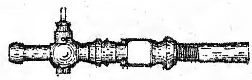


Fig. 183.—Riveted Seam.

casing is first lined with lead, 5 lb. or 6 lb. per ft. The recess B is lined with a piece worked cup-shaped and burned to the bottom piece. All the jointing in connection with this must be burned, no solder being admissible, except for attaching the outlet tap to the pipe taking off the

gas. A piece of 2-in. strong lead pipe is next fixed to the bottom of the lower chamber, dipping into the recess and attached so as to allow the liquid to flow freely up and down from one chamber to the other.

The diaphragm C may next be fixed, the pipe being tafted over and burned. This diaphragm must also be attached to the lead linings all round, and be quite water- and air-tight. Another hole is made in the diaphragm, and a piece of ½-in. 6-lb. lead pipe D is fixed over this, being bent at the top, and a tap fixed on as shown. This pipe is for carrying off the gas which is generated in the bottom portion. A perforated cover is now put on and attached to the lining, and the machine is ready for charging.



Fig, 185.

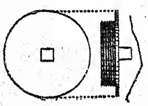


Fig. 184.—Hand Hole Cap of Hydrogen Generator.

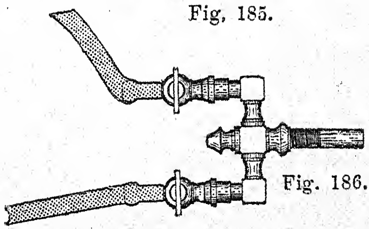


Fig. 186.

Figs. 185 and 186.—Side Elevation and Plan of Junction Piece.

Generally it is not advisable to use zinc clippings or old zinc that has been stripped from roofs, etc.; cast spelter should be obtained. This can be got in plates about 9 in. by 18 in., and from 1 in. to 1½ in. thick. It is broken up into convenient pieces, and placed in the machine through the hand-hole, not dropped or thrown in, or the lining and pipe may be damaged. From 14 lb. to 16 lb. may be put in, and the plugs screwed up tight. Next put about 2 gal. of water in at the top, and then about 1 qt. of good commercial sulphuric acid. Open the gas tap, and allow the air to escape from the bottom chamber. The liquid will then take the place of the air, and chemical action will be set up, hydrogen being evolved. Then the tap is shut, and

this part of the apparatus is ready for use. As the volume of gas increases, the liquid is gradually forced down and up the pipe into the top receptacle, so that when the lower part of the appliance is full of hydrogen the diluted acid is driven away from the zinc, and no further action takes place until the pressure of gas is relieved. The pipes are of ordinary rubber tube, $\frac{3}{8}$ in. in diameter, about 40 ft. being required; this is cut in two, one pipe to convey the air, and the other to carry the gas along to the breeches piece or junction piece (see Figs. 185 and 186), where the two gases are combined. This junction piece is easily made up by screwing two elbow-burner sockets into a brass T-piece, fitting a tap for hose connection into each elbow, and a straight brass nipple into the other socket of the T, as shown. A short piece of rubber tube connects this with the jet (see Fig. 187), which is a brass arm slightly bent at one end and screwed. A cap with a small

Fig. 187.—Jet of Lead-burning Machine.

hole is fitted on, and this is the point at which the mixture of gas and air issues and is burnt.

The supply of air is required to be in a steady, constant stream, and under pressure, and is obtained from the machine shown by Figs. 176 and 188 to 191. It is a simple appliance, and may be made up of strong zinc or galvanised iron. It consists of two chambers connected by a pipe perforated as shown, and an air pump is connected to the lower chamber. A tap fixed in the side forms the air outlet, to which the rubber tube is connected. Water is poured into the top portion of the appliance, flowing down the pipe and filling the lower part; then air is pumped in, which forces the water back into the upper chamber. This weight of water exerts a pressure on the air below, and when the tap is opened the air is displaced by the water. When the supply is exhausted, the pump is again brought into requisition, and the same operation is repeated. A continuous supply of air is thus available, and,

like the gas supply, is regulated by means of the taps on the junction piece.

Experience will enable the operator to determine when he has the right proportions of gas and air. The following remarks, however, will afford an idea as to the colour

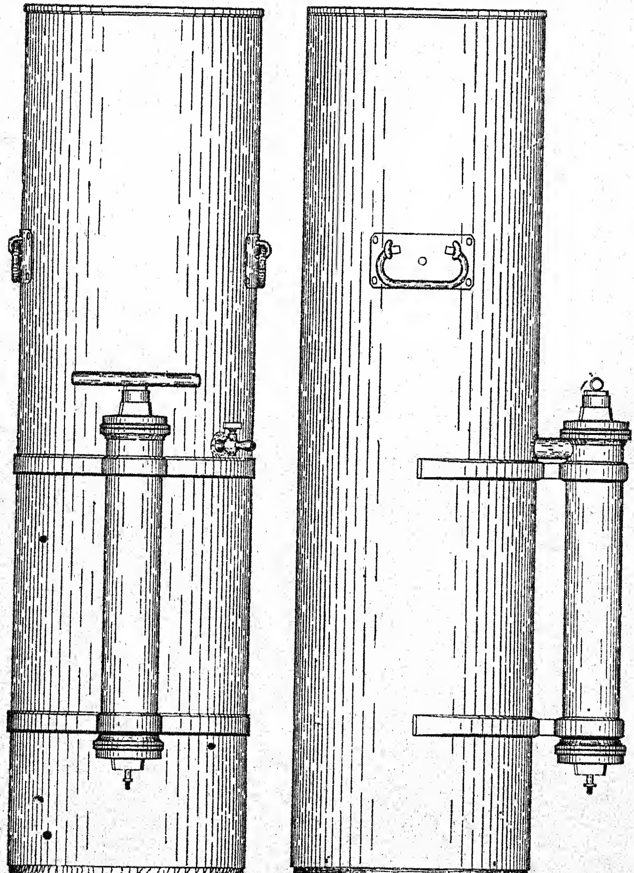
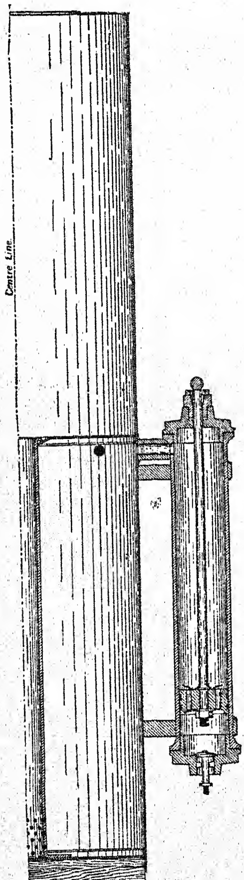


Fig. 188. Fig. 189.

Figs. 188 and 189.—Front and Side Elevations of Air Machine.

and size of the flame necessary. Without wind (air), or with insufficient wind, the flame will be of a yellowish



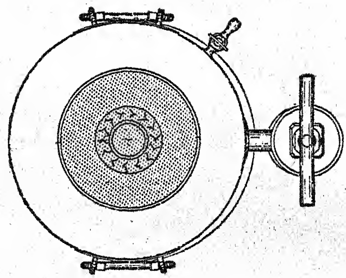



Fig. 191.—Plan of Air Machine.

Fig. 190.—Part Section of Air Machine.

colour and of rugged appearance. This kind of flame is useless for burning. Sufficient air must be mixed with it

to cause the flame to become pencil-shaped and of a bluish tint. When the flame is in this condition, it is ready for use. Too much wind, however, must not be used, or the flame will go out completely. The wind-cock should be opened gently to prevent this sudden extinction. Sometimes the dilute acid is blown out of the burner with the gas, causing the flame to become irregular, and finally to go out. When this takes place, it is an indication that the acid is too strong and generates the gas too quickly. The obvious remedy is further dilution of the acid.

Notes to be remembered when using a lead-burning machine are as follows:—(1) Care must be taken not to stand over the machine when it is charged with acid, in

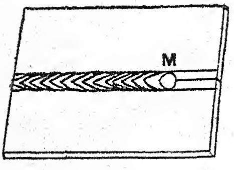



Fig. 192.—Butted Seam Partly Burnt.

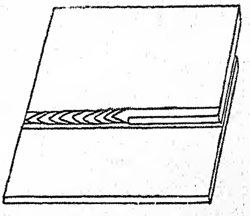


Fig. 193.—Lapped Seam Partly Burnt.

case the acid should bubble up (which it often does) and splash the operator. (2) The gas should not be allowed to escape in large quantities. (3) An old-type machine should only be charged up with sufficient acid to do the job in hand. (4) In no circumstances must the gas be burnt at the nozzle on the gas-making machine; if a match is applied to light it at this nozzle, in all probability it will light back to the chamber and explode. (5) In recharging the machine a light must not be brought anywhere near or an explosion will take place. A light must not in any circumstances be brought close to the machine when it is charged up. (6) An old-type machine must be thoroughly cleaned out with water (preferably hot) after use, especially the gas-making chamber, in order to dissolve and wash out the accumulation of sulphate of zinc, and to wash out the acid, to prevent it from continually generating gas. Only

points 2, 4, and 5 are of especial application to a modern machine of the type last described.

The seams in sheet lead-burning are of two kinds: one forming a butted joint, the other a lapped joint. In burning a butted seam the two edges of the lead to be joined are butted together, and shaved about $\frac{1}{4}$ to $\frac{3}{8}$ in. or slightly less on each side. The gas and air are turned on and adjusted so as to produce a flame from about 5 in. to 6 in. long, and tapering to a fine point. The hottest part of the flame is the centre of the thickest portion, about 1 in. or $1\frac{1}{2}$ in. from the jet. Hold the jet in the right hand, and a strip of lead in the left, and allow the flame to play on the end of the strip, which is held just above the seam. As the

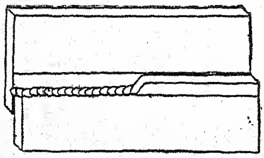


Fig. 194.—Horizontal or Side Burning.

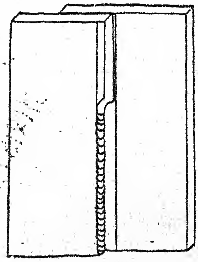


Fig. 195.—Vertical or Upright Burning.

strip melts, the jet is diverted on to the seam, so as to fuse the edges together, the additional lead forming a thickened portion. The strip is again melted, and joined to the edges, and also to the thickest part, and so on along the length. Care should be taken to burn the lead through, but not for the metal to flow beneath the seam. After a little practice, the operator will know exactly when to apply and when to remove the jet. Fig. 192 shows a flat butted joint partly burnt. The stick of lead is just nipped with the flame, and a bead of lead dropped on the seam. The flame is then directed on to this bead until it is fused with the seam. When bead and seam are melted together, the flame is immediately raised. The next bead of lead is then dropped on the

seam so as to half-cover the previous bead, as shown at M (Fig. 192). The flame is then directed on the second bead, fusing it to the seam and the previous bead, the flame being immediately raised after these are fused together; and this operation is repeated until the whole of the seam is burnt.

Fig. 193 shows a flat lapped joint, partly burnt. In burning this joint, the stick of lead is only required to fill up any irregularities in the burning, and is not required to form the seam in the same way as it is in a butted joint, because in lapped burning the overcloak is burnt down on to the undercloak, as shown at Fig. 194.

In horizontal and vertical burning, lapped joints only

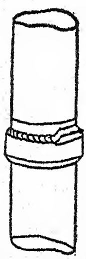


Fig. 196.—Burning Upright Joint.



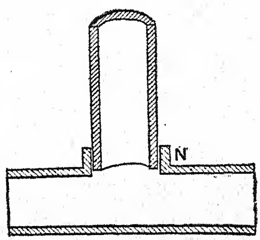



Fig. 197.—Branch Joint Ready for Burning.

should be used. Fig. 194 shows a specimen of horizontal or side burning, and Fig. 195 one of vertical or upright burning. In burning either of these, the stick of lead is not required at all, the overcloak being in each case burnt down on to the undercloak. Care must be taken that both the overcloak and undercloak of a lapped joint are well shaved. The seams should not be soiled or greased, and care must be taken not to tarnish them in any way. If the lead is not shaved quite clean, or if it becomes tarnished after it is shaved, it will be found difficult to burn it together successfully. In lining cisterns, the joints must always be kept well out of the angles; otherwise the job will become long and difficult.

In burning a vertical lapped seam, starting at the bottom, the lapping lead is melted, and as it runs is turned

on to the back portion and fused into it. A slight projection is formed, which holds the next melting, and so on, each layer forming a base for the next, and adding to the height until the top is reached. No tallow or smudge is necessary. The operator will soon detect the presence of any foreign substance or dirt on the lead, and the shavehook should be kept handy to remove it.

In practising either horizontal or vertical burning, the student should first place his burning at an easy angle—say, at about 25° or 30°—gradually raising it as he becomes proficient, until the seam is in a horizontal or vertical position as desired. Two surfaces can be burned together in any position—horizontal, vertical, or even overhead, where soldering would be impossible.

Pipe joints can also be made by burning. First one pipe is opened to form a socket like a slip joint. The male part, which must enter at least $\frac{3}{4}$ in., must be well shaved and made to fit tight. Fig. 196 shows an upright joint prepared and partly burnt. Fig. 197 shows a section of a branch joint as prepared for burning. Care must be taken to work up a good thick shoulder for the socket N.

The seams on hand-made soil and rainwater pipes are also often burnt together instead of being soldered in the usual way, butted joints being used for this purpose. An iron mandrel or pipe is placed inside the pipe to prevent the lead from running through during the process. The mandrel should be slightly warmed before the burning is begun.

## CHAPTER VII.

### LEADWORK ON ROOFS.

Flats and roofs are covered with sheet lead because of the eminent fitness of this material for use in situations exposed to the action of air and water. Some few years ago, Mr. George Ewart in an essay upon sheet metal as a roof-covering, said that if the question of durability were merely one of weight, lead would be nearly twice as durable as zinc, and at least a third more durable than copper. The firmness of the material can best be indicated, perhaps, by the relative amount of conductivity, which in lead may be represented as 230; nearly twice as high in zinc, say 430; while in copper it is more than twice as high as zinc, and more than four times as high as lead, namely 1,000. The conclusion arrived at from these figures is strengthened by the figures representing the fusibility of the different metals, namely lead, 617° F.; zinc, 800° F.; and copper, nearly four times that of lead, and nearly three times that of zinc, namely 2,143° F. Roughly, it may be said that lead and copper are of about equal durability, particularly as neither of these metals is easily acted upon by acids.

The softness of lead has its advantages, since it is easy to use it of great thickness; thus lead may be laid of a thickness weighing perhaps 6 lb. or 7 lb. to the square foot as easily as copper weighing only 16 oz. or 18 oz. to the foot. Lead of 7 lb. to the foot forms a practically permanent covering, lasting upwards of a hundred years, if properly laid and in favourable situations.

Flat roofs are very likely to be walked over, and to have things placed upon them, round or under which dirt and moisture can collect. On account of its extreme softness, lead, unless very thick, is easily damaged by traffic; and zinc, although harder, is brittle, and is also easily corroded by foreign matter; and both, as already mentioned, are exceedingly liable to buckles and cracks. Copper, on the

other hand, is so tough that it is practically uninjured by traffic and little liable to corrosion. It should, however, be laid with wood rolls and welted caps, and not according to the old method of stand-up welts.

For sloping roofs and towers or spires the great weight

Fig. 198.—Lap Joint.

Fig. 199.—Plain Soldered Joint.

of lead is much against its use. In such positions lead has a habit of crawling down, as it is called, and this is a very destructive process and greatly shortens its usefulness. It is said that the lead on the roof of Bristol Cathedral crawled down as much as 18 in. in two years. The extreme softness of lead makes it also unfit for ornamental work. It is always necessary, when lead is being used, that the wood should first be formed into the shapes, and the lead dressed closely over these; on account of their stiffness zinc and copper do not require the mouldings and ornaments to be formed in the wood, but are sufficiently supported by a rough wood core.

Lead has been so very largely used for roofs for many hundreds of years, that it is unnecessary to quote instances as to its lasting power when properly laid on flat roofs. With regard to its weight, it is found that when allowance has been made for the necessary rolls and laps, the lead necessary to cover a square of 100 ft. weighs rather more than the slates which would be necessary to cover the same area, and about half as much as plain tiles.

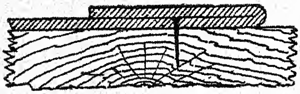


Fig. 200.—Single or Nail Welt.

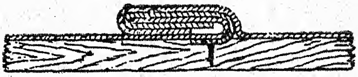


Fig. 201.—Double Welt.

The term "workableness" must be understood to mean the possibility of being turned up with moderately sharp angles and twisted over into welts. Although lead is so soft, yet, on account of its great thickness, it cannot be easily welted, and requires large rolls. On the other

hand, its weight and softness incline it to lie close even without joints—only then, of course, it is easily displaced.

As a fireproof material, copper is undoubtedly better than lead or zinc. As already stated, lead melts at 617° F., and therefore in a fire it soon pours down in a terrible

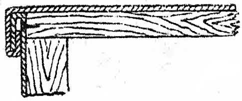


Fig. 202.—Welted Edge of Lead Flat.

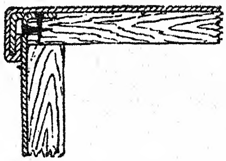


Fig. 203.—Secret Tack to Edge of Lead Flat.

stream, more dangerous than even falling timbers or bricks. Zinc melts at 800° F., and blazes brightly if thrown into an ordinary coal fire. Copper requires a temperature of 2,143° F. to fuse it, and retains its shape even at white heat.

Another property required in a roof covering is insonorousness. Here lead has the immense advantage of its exceeding softness, and the same quality of softness

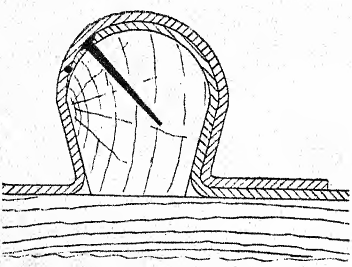


Fig. 204.—Solid Wood Roll.

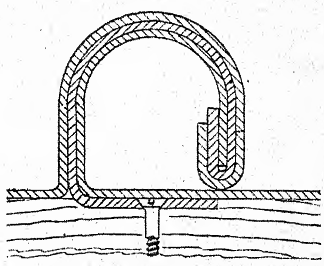


Fig. 205.—Hollow Roll.

makes it a non-conductor of heat. Lead has the advantage over copper of making much less noise in a driving rain or a hailstorm, but copper has perhaps still greater advantages over lead, being only about one-sixth the weight, being almost absolutely fireproof, requiring very little support

in ornamental work, having only a little more than half the expansiveness under heat, and, consequently, requiring fewer drips. To these advantages may be added its

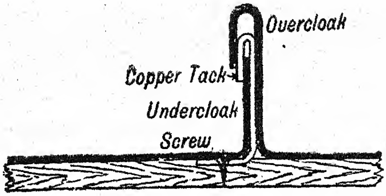



Fig. 206.—Seam Roll Ready for Folding.

capacity of being easily welted, and, finally, the beautiful colour which it assumes after a few years of exposure to a damp atmosphere.

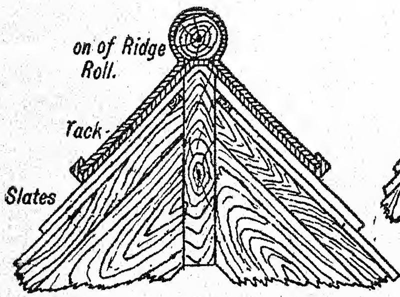



Fig. 207.—Section of Ridge Roll.

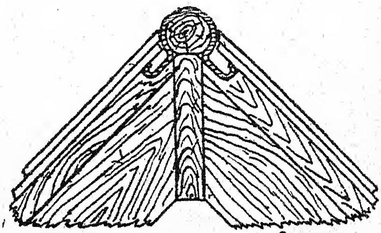


Fig. 208.—Section of Secret Hip Roll.

The weights of sheet lead are varied according to the class of work, and may be graded as follows:—

| | Pounds per sq. ft. | | |
|---|---|---|---|
| Cistern bottoms ... ... | 6 | 8 | 10 |
| ,, sides ... ... | 5 | 7 | 8 |
| Flats ... ... ... ... | 6 | 7 | 8 |
| Gutters ... ... ... | 6 | 7 | 8 |
| Valley gutters ... ... | 6 | 7 | 8 |
| Ridge ... ... ... ... | 5 | 6 | 7 |
| Hips ... ... ... ... | 5 | 6 | 7 |
| Flashings ... ... ... | 4 | 5 | 6 |

The methods of jointing sheet lead are as follows:—First, there is the simple lap joint (Fig. 198), which is from 2 in. to 6 in. wide according to circumstances. The lapped

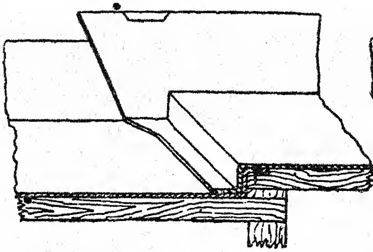


Fig. 209.—Square Gutter Drip.

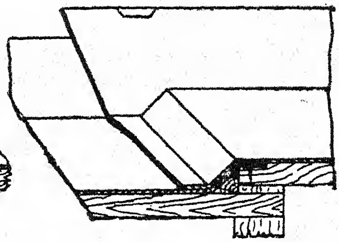


Fig. 210.—Splayed Gutter Drip.

parts should be copper nailed, and the joint is suitable only for steep slopes and vertical sides.

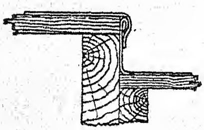


Fig. 211.

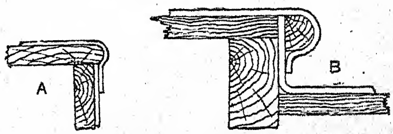



Fig. 212.

Fig. 211.—Hollownose Drip. Fig. 212.—Bottlenose Drips.

The seam or plain soldered joint (Fig. 199) is used for the same purposes as the lap joint.

Fig. 213.—Welted Drip.

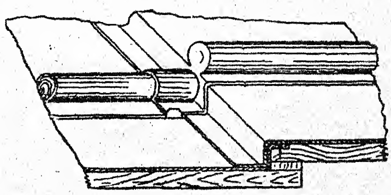


Fig. 214.—Roll End and Drip.

The simplest form of welt joint is illustrated by Fig. 200; it is known as the single welt or nail welt. A double welt is shown by Fig. 201. Fig. 202 illustrates in section

the welted edge of a lead flat; Fig. 203 is similar, but shows a secret tack.

Where the part to be covered is exposed to the weather, and is wider than one sheet of lead will cover, it is usual to form a roll between the sheets, laid with a fall of $1\frac{1}{2}$ in.

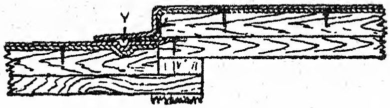



Fig. 215.—Roll with Water Groove.

in 10 ft., longitudinally. The roll may be solid, as Fig. 204, which is the method adopted for hips and rolls in general, but on flats they may be hollow, as Fig. 205. A section of a seam roll ready for folding is given by Fig. 206, which shows it to be made up of a lead overcloak and undercloak and a copper tack or strip. Sections of a ridge roll and of a secret hip roll are given by Figs. 207 and 208 respectively.

At the ends of lead sheets, across the current, it is usual to form a "drip," as in Figs. 209 to 214. Fig. 209 is a

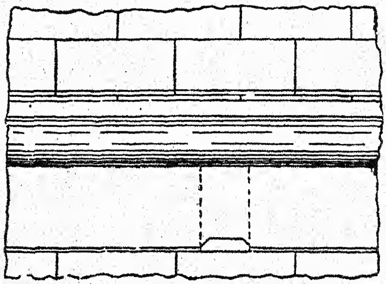


Fig. 216.—Elevation of Taurus or Curb Roll.

view and section of a square gutter drip, and Fig. 210 of a splayed drip—a fillet occupies the angle. A "hollow-nose drip" is shown by Fig. 211. A "bottle-nose drip" is so called when the boarding carrying the upper sheet of lead projects over the bearer, the lower sheet of lead being

stopped at the under-side of the projection and the upper sheet dressed down over the projection and the upper edge

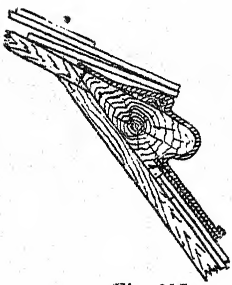


Fig. 217.

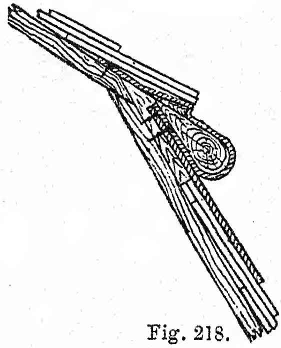


Fig. 218.

Figs. 217 and 218.—Sections of Taurus or Curb Roll.

of lower sheet, as at A (Fig. 212). At B is shown the improved bottle-nose drip. A welted drip is represented by Fig. 213, whilst Fig. 214 is a view of a roll end and drip on a lead flat, and Fig. 215 is a sectional view of lead rolls showing a water-groove at Y to prevent capillarity.

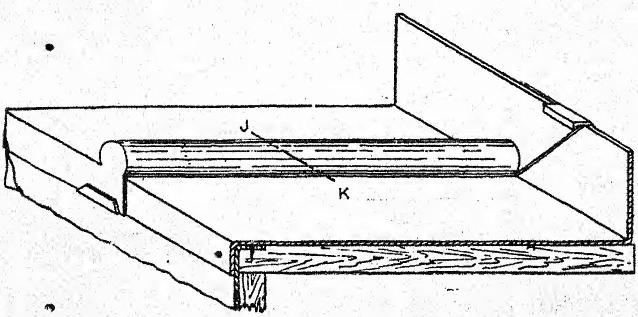



Fig. 219.—Seam Roll with Bossed Ends.

A taurus, torus or curb roll, is shown in Figs. 216 to 218. Views of a seam roll and finished roll with bossed ends

are given by Figs. 219 and 220, a section on the line J K (Fig. 219) being presented by Fig. 221.

A raglet is a narrow groove, about 1 in. deep, cut in masonry to receive the top edge of an apron flashing, as in Fig. 222. When the raglet occurs in the top of a blocking

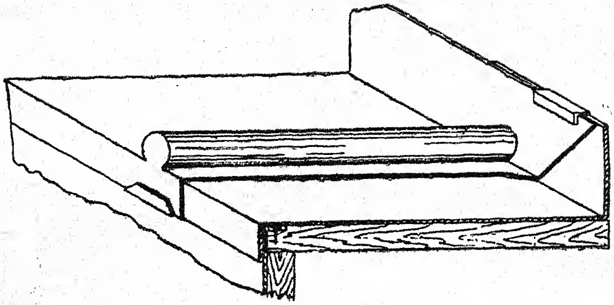


Fig. 220.—Finished Roll with Bossed Ends.

course, the process of "burning-in" is adopted to hold the sheet lead, that is, an under-cut groove is formed for the raglet, and molten lead run in, as in Fig. 223.

When sheet lead is laid on with more slope than is just necessary to permit the water to run off, it is held by "soldered dots," as in Fig. 224. The boarding is countersunk, the lead dressed down into the depression, and a screw put through, solder being run over the screw to keep the wet out.

The chief work of a plumber on a roof is usually con-

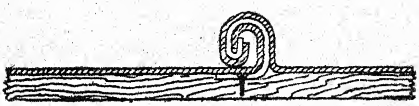


Fig. 221.—Section of Seam Roll.

nected with flats and gutters which have to be covered with sheet lead; but before lead-laying is begun, the joiner's work should receive special attention. The boards forming the floor for the lead should be well seasoned, and tongued and grooved; and they should rest upon a firm

and solid bed so that they will not spring when walked upon. The length of the boards should be in the direction of the fall, which ought never to be less than $\frac{1}{8}$ in. to the foot, the surface should be free from projections and irregularities, and the fixing nails should be punched well into

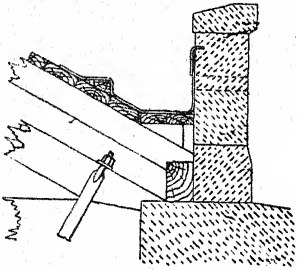


Fig. 222.—Raglet in Stone Parapet.

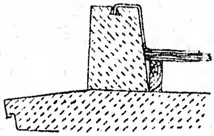


Fig. 223.—Raglet in Top of Blocking Course.

the board. The drips should not be less than 2 in. high, with the top edge rebated to allow the undercloak lead to be flush with the board. The length from drip to drip should not exceed 10 ft., and the width between rolls not more than 2 ft. 9 in. The gutter should be wide enough to walk

Fig. 224.—Soldered Dot.

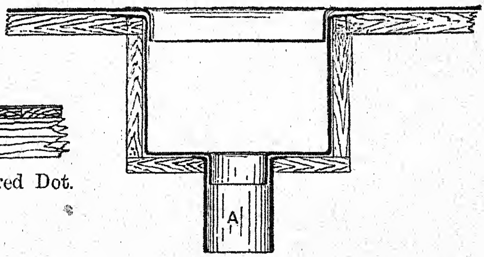



Fig. 225.—Gutter Cesspool.

in at its narrowest point; and, if over 3 ft. wide, a roll should be fixed down the middle.

The expanding and contracting influences of heat and cold must be taken into account, and if the lead is laid in too great lengths, or in too wide bays, it will soon break

or crack; but if laid according to the directions just given, the drips and laps will allow sufficient freedom of movement to counteract this tendency.

The point at which lead laying should be started is the

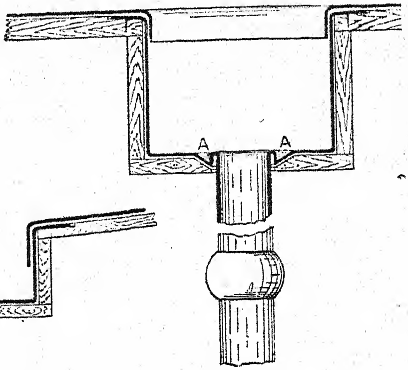



Fig. 227.

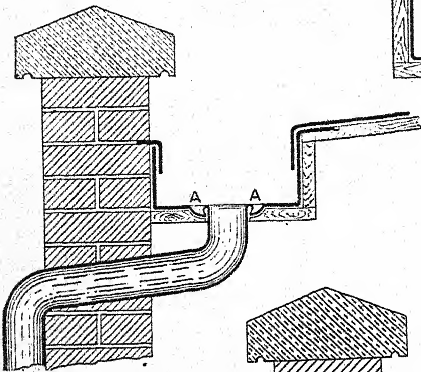



Fig. 226.

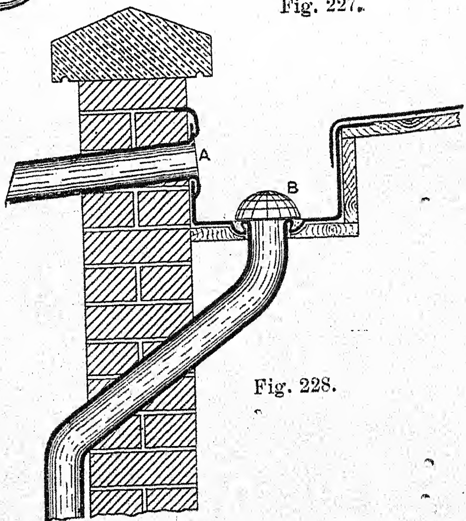



Fig. 228.

Figs. 226 and 227.—Gutter Cesspools with Down-pipes Respectively Outside and Inside External Wall. Fig. 228.—Cesspool with Overflow Pipe.

cesspool, which is a box fixed at the lowest point in the gutter, and from which the rainwater pipe descends. The

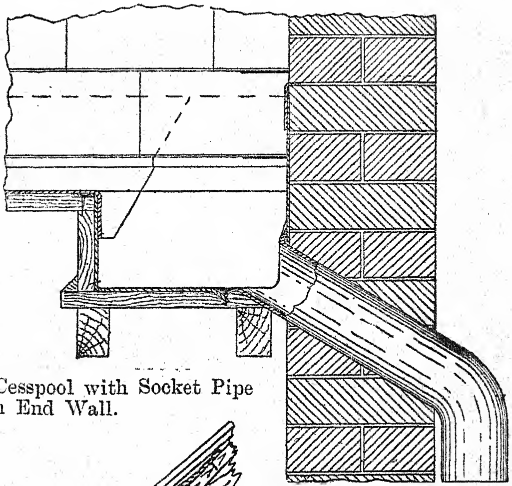


Fig. 229.—Drip and Cesspool with Socket Pipe through End Wall.

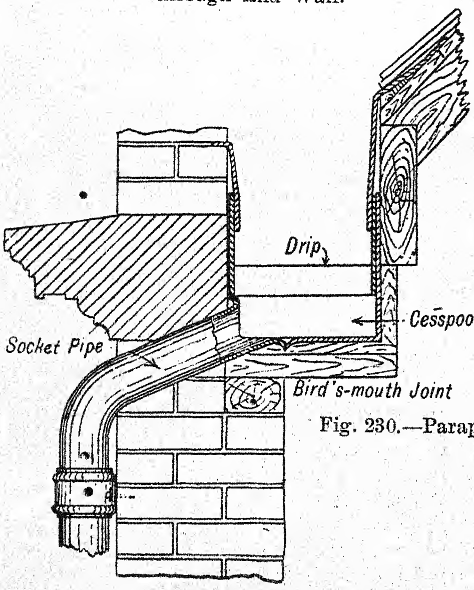



Fig. 230.—Parapet Box Gutter.

lead to line this can be cut and soldered on the bench to the size and shape required. When cutting out the lead for lining a cesspool, it is usual to allow 6 in. above the gutter line on the wall side, and 9 in. above the gutter line on the roof side; but, before this lining is put in, a hole

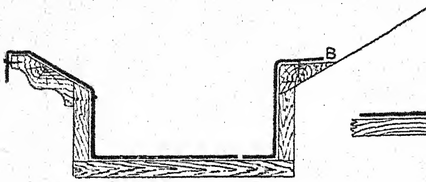



Fig. 231.—Box Gutter.

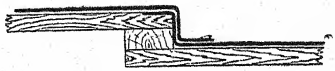


Fig. 232.—Drip.

must be cut in the bottom of the cesspool and a lead nozzle inserted, about 6 in. long, and of the same diameter as the rainwater pipe, as is shown at A (Fig. 225), and the top edge dressed back and nailed with copper tacks to the wood. The lining is then put in; and it should fit closely to the wood on each side, and rest solidly on the bottom. Tap the bottom lightly with the mallet, and trace the position of the nozzle; then make a small hole in the centre and dress the lead down into the nozzle, using care to pre-

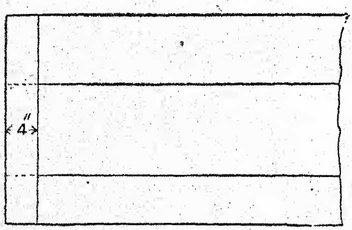



Fig. 233.—Setting out Lead for Gutter.

Fig. 234.—Scribing Gauge.

vent tearing of the lead in working. The top edges of the lead cesspool are to be turned over on to the gutter board and secured by nailing. To avoid the risk of flooding due to stoppage caused by leaves, etc., an overflow pipe could be inserted in the side of the cesspool and carried to some position where an overflow could be immediately observed.

It must be pointed out that the right method of doing this work is a matter of rather keen controversy. Fig. 226 shows an ordinary cesspool in a box or parapet gutter with the down-pipe arranged to be on the outside of an external wall; Fig. 227 shows a very similar construction which can be adopted when the pipe is compulsorily carried down inside the wall. The essential point of difference between these methods and the one shown by Fig. 225 is that here wiped soldered joints are employed at A A, whereas in Fig. 225 the top of the pipe is merely dressed

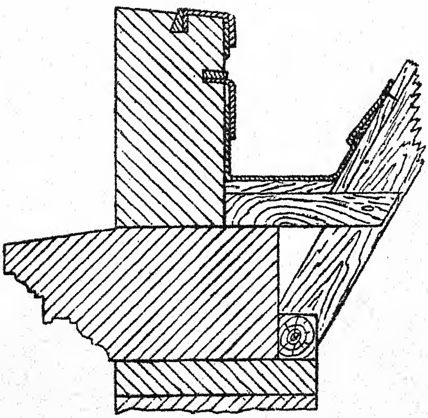


Fig. 235.—Section of Parapet Gutter.

back and nailed under the lining. The wiped joints must be made in position. Figs. 226 to 228 show better methods. Overflow pipes should be fitted to the cesspools shown in Figs. 226 and 227. Such a pipe is indicated by A in Fig. 228; its purpose is to carry off water (should the cesspool become stopped) before the water can penetrate under the drips and lining. B indicates a wire guard to prevent leaves, etc., passing into the down-pipe and blocking it.

Sectional views of other arrangements of cesspool and socket pipe are presented by Figs. 229 and 230.

When measuring the lead for a box gutter (Fig. 231), allow 2 in. beyond the edge of the moulding, and 3 in. to

lap over the springing fillet B. When the lead is cut, lay three or four boards, edge to edge, on the feet of the spars, upon which the lead can be rolled out. Set out the bottom and sides, and, with the chalk line, strike the lines which

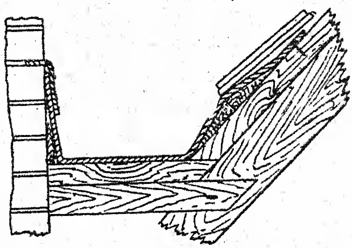


Fig. 236.—Parapet Gutter with Double Springing.

represent the two angles; then take a piece of scantling, about the same length as the lead, and place it with one of its edges just on the chalk line, and pull the lead up at right angles. Do the same with the other side, when the lead will look like a square trough. The drip (Fig. 232) must now be bossed up. For a 2-in. drip, set out a line parallel with, and 4 in. distance from, the end of the lead. This cuts the other two lines at right angles, and forms

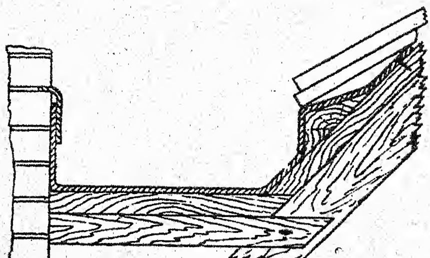


Fig. 237.—Parapet Gutter for Tiled Roof.

three sides of a square—Fig. 233 explains this—then, with the chase-wedge and mallet, set in the angles, turn the lead up, and boss the two corners 2 in. high; drop the lead into its place, set in the corners and angles with the flat

dresser and mallet, and turn down the laps at each end as shown by Fig. 232. The next length can be treated similarly, and so on until the gutter is finished.

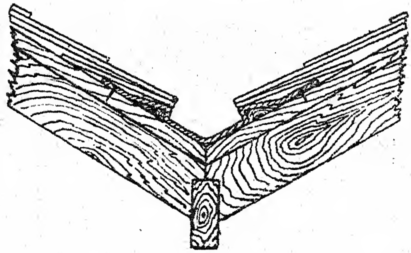


Fig. 238.—Valley Gutter.

To make a good finish on the front of the cornice, the projecting lead should be gauged and the surplus cut off. This is done with a tool similar to that shown in Fig. 234, which can be easily made out of a piece of wood, the scriber being driven through, say, $1\frac{1}{4}$ in. from the end. Run the gauge along the projecting edge of the lead with one of its legs pressed close to the moulding, and the scriber will then mark the line where the lead has to be cut. When this is done, dress the remainder down over the cornice, and by means of secret tacks secure the free edge against being lifted by a high wind.

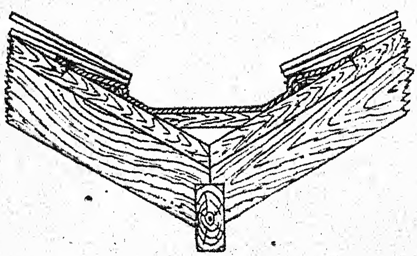


Fig. 239.—Valley Gutter.

For a parapet gutter (Figs. 226, 228, and 230, pp. 114 and 115), the lead must be turned up the wall, 6 in. high, and capped with a separate flashing.

Gutters are of many kinds, the chief of which will now be illustrated. Some parapet box gutters have already been referred to; Fig. 235 shows another, with the lead flashing "burned in" to stone blocking, or secured as at

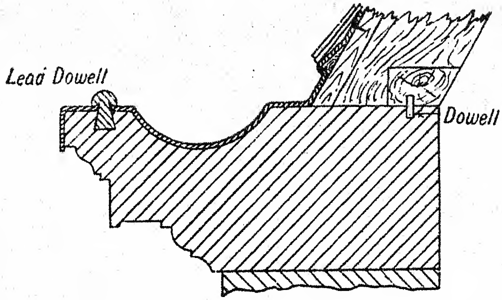



Fig. 240.—Section of Cornice Gutter.

x. The parapet gutter shown by Fig. 236 has a wood fillet to protect the lead from rough brickwork; and there is a double springing on the roof to prevent the lead buckling. Fig. 237 represents the section of a gutter with extra thick springing for a tiled roof. Two different

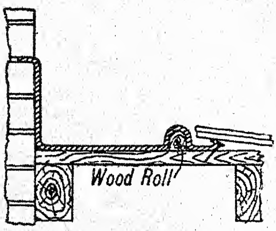



Fig. 241.—Upright Gutter.

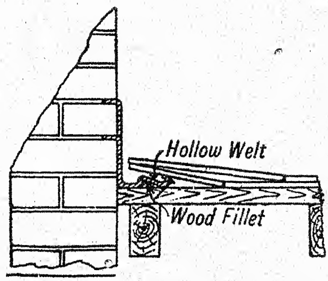



Fig. 242.—Secret Gutter.

sections of valley gutters are given by Figs. 238 and 239, and a cornice gutter is shown by Fig. 240. An upright gutter or a gutter on the slope of a Mansard roof is illustrated by Fig. 241, and Figs. 242 and 243 show alternate

methods of constructing a secret gutter next to the wall end of a slated or tiled roof. Secret hip gutters are shown in section by Figs. 244 and 245.

In determining the size of a roof gutter, other details

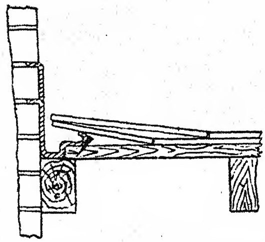


Fig. 243.—Secret Gutter.

besides rainfall have to be considered. The gutter is used for walking in when anything is required to be done to the roof, and it should be so wide that the workmen will not tread on the slates or tiles and so break or injure them. The general rule is for plain rainwater gutters to be 12 in. wide in the sole at the narrowest part. A gutter, say, 43 ft. long could not be cut out of one piece of lead. For convenience of laying the lead, and to allow for expansion and

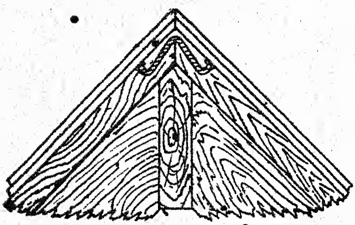


Fig. 244.

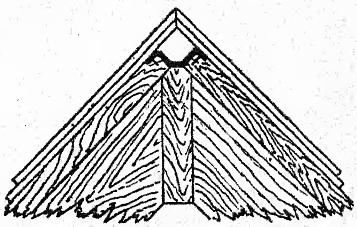


Fig. 245.

Figs. 244 and 245.—Secret Hip Gutters.

contraction, the gutter should be divided into five lengths, which would necessitate four drips, and to resist capillarity the latter should not be less than 2 in. deep. (The illustrations given in this chapter should be referred to for

the construction.) Assuming that the gutter falls $1\frac{1}{2}$ in. between the drips, the width of the gutter sole at the highest end will be 4 ft. 11 in., and at the other and narrower end, 1 ft. With such a gutter there would be little risk from overflow during a storm, especially if the outlet end is continued through the wall to empty into the head of a down-pipe. For calculating the water that falls on the roof, first find the area of that portion emptying into the centre gutter; assume it to be 32 ft. by 43 ft., or 1,376 super ft. If, during a rain-storm, $\frac{1}{2}$ in. of water falls in ten minutes, $1{,}376 \div (2 \times 12) = 57\frac{1}{3}$ cub. ft. This, taken as 1 in. deep by width of gutter, or 1 ft. = 688 lin. ft. Then, 688 ft. by 1 in. deep, runs out of the gutter in ten minutes, or 68·8 ft. in one minute, or 1·146 ft. in one second. The gutter having a fall of $1\frac{1}{2}$ in. in 9 ft., or one in seventy-two, the water would attain a velocity of about 3 ft. per second. This velocity would cause the water to be of less depth than 1 in. To find the actual depth, $\frac{1{\cdot}146 \times 1 \text{ in.}}{3} = {\cdot}382$, or a little over $\frac{3}{8}$ in. This shows the gutter to be of ample size. A 3-in. down-pipe, with hopper head, would be quite large enough. The rainfall of $\frac{1}{2}$ in. in ten minutes is extraordinary, but it has actually occurred.

Water grooves to prevent water being drawn in by capillary attraction are necessary in all laps or passings where these are on either flat or sloping roofs, but not when the laps and passings are in upright positions. Fig. 246 is a plan of a drip in a box gutter, showing the lap on the curb of the roof; Fig. 247 is an elevation of the lap on the curb; Fig. 248 is a section of the curb. Fig. 249 is a section on A B of the water groove, drawn to a larger scale. The water groove is shown by double dotted lines in Figs. 246 and 247, and by firm lines on Fig. 248.

The proper way of laying lead valley gutters (Figs. 238 and 239, p. 119) is as follows:—Have the bottom of the gutter covered with good boards, 4 in. wide, planed to an even surface, the grain of the wood arranged parallel with the length of the gutter. Arrange a drip of 2 in. every 7 ft., and allow a fall of 1 in. between drips. Fix the tilting fillets on each side 3 in. from the sole of the gutter, and allow the lead to lie 6 in. under the slates.

The laying of a lead flat will now be discussed. For

a proper lead flat, the boards should be laid to a fall of about 2 in. in 10 ft., with their grain in the direction of the current, and they should be quite free from bumps and irregularities. If too much fall is given, the lead will "crawl" down, unless special means are taken to prevent it. Drips should not be less than 2 in. deep. Rolls should be 2 in. thick, and fixed 2 ft. 9 in. apart. The lead should be "soft" milled or cast, of equal thickness, and weigh not less than 7 lb. per square foot, and be turned up 6 in.

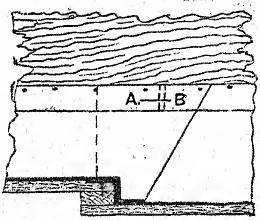



Fig. 247.—Elevation of Lap on Curb.

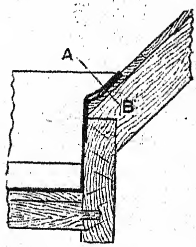



Fig. 248.—Section of Curb.

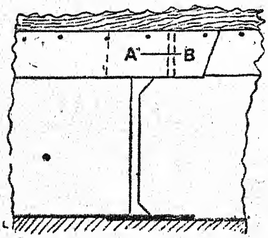



Fig. 246.—Plan of Drip in Box Gutter.

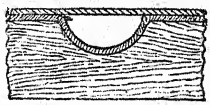


Fig. 249.—Section showing Water Groove.

against walls. Copper nails 1¼ in. long should be used for nailing the lead where necessary, but the fixings should not be too rigid, or so as to resist expansion of the lead. Flashings should be of 5-lb. lead, turned into walls not less than 1¼ in., hang 3 in. over the stand-up lead on flat, and be fixed with lead wedges. The free edges of flashings should be secured by means of 6-lb. lead "tacks" 3 in. wide. Copper tacks are sometimes used, and are very good, but with zinc tacks a voltaic action sets up between the metals, and the zinc is soon destroyed.

The finishing off of rolls and drips on a lead flat is a subject of misunderstanding to many plumbers, who think that the overcloak should finish as at A (Figs. 250 and 251), whereas the correct method is that shown by C (Fig. 252) and D (Fig. 251). By continuing the overcloak about 1 in. to $1\frac{1}{2}$ in. on to the flat, the edge of the lead is stiffened.

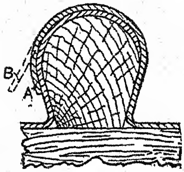



Fig. 250.

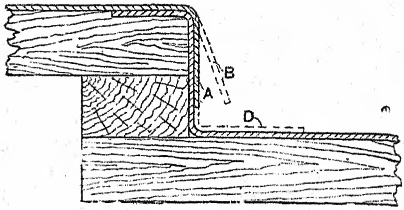



Fig. 251.

Figs. 250 and 251.—Overcloak Wrongly Finished.

Without this the edge opens away from the roll, especially when careless people step upon it, and wind and rain get beneath. In practice, it is found that water will not rise so high, by capillarity, with the lay-piece left on. The fold round the roll acts as a fixing by its grip, and, in addition to its usefulness, the work looks much better. When the overcloak lead is cut short as shown at A (see Figs. 250 and 251) the lead does not fit tightly to the roll

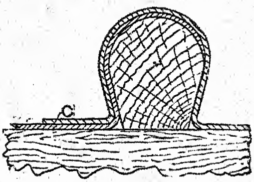



Fig. 252.—Overcloak Correctly Finished.

or drip, and there is nothing to prevent the lead rising when expanded by heat, and the free edge is also liable to be blown up by a high wind, or to be pressed outwards, as shown by dotted lines at B B, by anyone stepping on the rolls or on the edges of the drips. When the free edges are thus opened, water, when rain is falling, will

splash beneath and thus wet and eventually rot the woodwork. Cutting the head short does not prevent the water rising by capillary action, but really shortens the distance the water has to travel to reach the woodwork. Lead

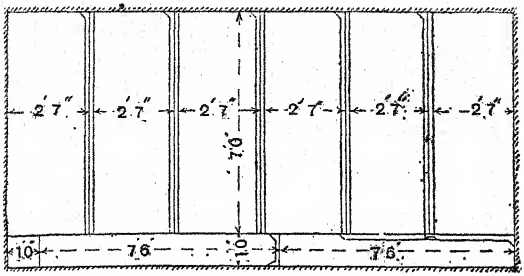



Fig. 253.—Setting Out Lead Flat.

should be fixed to allow for expansion, or it will break; and the lead overcloak should grip the roll tightly enough to form a fixing, and yet allow for expansion.

Fig 253 shows how to set out a flat, 16 ft. by 8 ft., having bays, gutter, and cesspool; 7-lb. lead should be used for the flat, gutter, and cesspool, and 5-lb. for the flashings.

Dimensions of flat:—

| | | | |
|---|---|---|---|
| | 16′ | 0″ | Total length of flat. |
| 2/ 6″ = | 1 | 0 | Turn up against end walls. |
| 5/ 9″ = | 3 | 9 | For the rolls, allowing $3\frac{1}{2}''$ under-cloak, and $6\frac{1}{2}''$ over-cloak—1″ for base of each roll. |
| | 20 | 9 | = Total length of lead on flat only. |
| | 7 | 0 | Length of bays. |
| | 0 | 6 | Turn up against top wall. |
| | 0 | 4 | Turn down into gutter. |
| | 7 | 10 | = Total length of lead on flat only. |

Dimensions of gutter:—

| | | | |
|---|---|---|---|
| | 16′ | 0″ | Total length, including cesspool. |
| | 0 | 8 | Allowance for lap at one drip. |
| | 0 | 4 | Do. for $\frac{1}{2}$ lap at cesspool drip. |
| 2/ 6″ = | 1 | 0 | Turn up at end walls. |
| | 18 | 0 | = Total length of gutter lead. |

1′ 0″ Width of gutter bottom.
0 6 Turn up against wall.
* 0 7 Do. do. flat drip.

2 1 = Total average width of gutter lead.

2″ drip.
2 fall.
2 drip.
2 fall.

8 deep at lower end.
2 do. at highest end.

10 ÷ 2 = 5″ average depth.
+ 2 for turning on flat.

7″ carried to *.

For the extra depth of cesspool, which is 6″ deep, there is :—

4/ 1′ 0″ = 4′ 0″ = length of sides.
× 0 6 = depth.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Then | 20′ | 9″ | | | 18′ | 0″ | |
| | 7 | 10 | | | 2 | 1 | |
| | 145 | 3 | | | 36 | 0 | |
| | 17 | 3 | 6‴ | | 1 | 6 | |
| | 162 | 6 | 6 | lead on flat. | 37 | 6 | lead in gutter. |

4′ 0″
0 6

2 0 extra lead in cesspool.

| | | | | |
|---|---|---|---|---|
| And | 162′ | 6″ | 6‴ | flat lead |
| | 37 | 6 | 0 | gutter lead |
| | 2 | 0 | 0 | cesspool lead |
| | 202 | 0 | 6 | = Total area of 7-lb. lead. |

And 202′ 0″ 6‴
7 weight of 1 ft. of lead

1414 3 6 = weight in lbs. of the whole ;
or 1414 $\frac{3}{12}$ $\frac{6}{144}$, or 1414$\frac{7}{23}$ lbs.

| | Cwt. | qr. | lb. | |
|---|---|---|---|---|
| 112) 1414 | (12 | 2 | $14\frac{7}{23}$ | = Weight of lead on flat. |
| 112 | | | | |
| 294 | | | | |
| 224 | | | | |
| 28) 70 | | | | |
| 56 | | | | |
| 14 | | | | |



Flashing :—

| | | | |
|---|---|---|---|
| | 16′ | 0″ | Length of flat |
| | 8 | 0 | width ,, |
| | 16 | 0 | length ,, |
| | 8 | 0 | width ,, |
| 0/ 4″ = | 2 | 8 | add for laps or passings. |
| | 50 | 8 | Total length of flashing |
| | 0 | 6 | average width of ,, |
| | 25 | 4 | Total dimension for flashings |
| | | 5 | weight of 1 ft. |
| | 126 | 8 | Total weight of flashing in lbs. |

| | Cwt. | qr. | lb. | |
|---|---|---|---|---|
| 112) $126\frac{2}{3}$ | (1 | 0 | $14\frac{2}{3}$ | = Total weight of flashings. |
| 112 | | | | |
| 28) 14 | | | | |

Assuming the tacks to flashings are 6″ × 3″ and 3′ 6″ apart then 48′ 0″ ÷ by 3′ 6″ = 14.

| | | | | |
|---|---|---|---|---|
| Then | 0′ | 6″ | | |
| | 0 | 3 | | |
| 14/0 | 1 | 6‴ | = 1′ 9″ 0‴ | |
| And | 1′ | 9″ | 0‴ | |
| | | | 5 | lb. lead. |
| | 8 | 9 | 0 | or 9 lb. nearly as total weight of tacks. |

| | Cwt. | qr. | lb. | |
|---|---|---|---|---|
| And | 12 | 2 | $14\frac{7}{23}$ | flat |
| | 1 | 0 | $14\frac{2}{3}$ | flashing |
| | 0 | 0 | 9 | tacks |
| | 13 | 3 | $9\frac{67}{69}$ | = Total weight of lead on flat. |

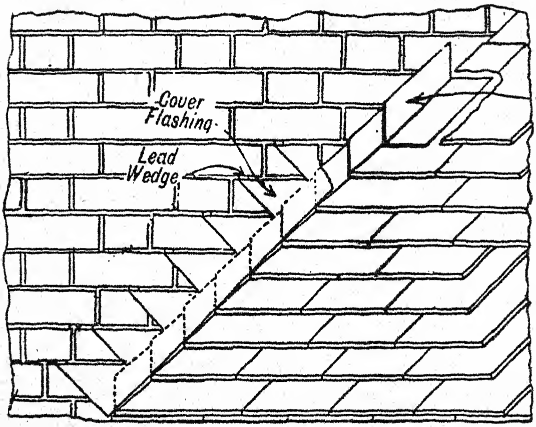



Fig. 254.—Lead Soakers on Tiled Roof.

For raising the lead shown above to a height of, say, 50 ft., certain tackle would be necessary.

The heaviest piece of lead being 7′ 0″ + 6″ + 4″ = 7′ 10″ × 2′ 7″ + 10″ + 3″ = 3′ 8″, and

| | | | |
|---|---|---|---|
| 7′ | 10″ | | |
| 3 | 8 | | |
| 23 | 6 | | |
| 5 | 2 | 8‴ | |
| 28 | 8 | 8 | superficial |
| | | 7 | weight of 1 ft. |
| 201 | 0 | 8 | or a little over $1\frac{3}{4}$ cwt. |

For hoisting this a pair of "shear legs," or two short

stout poles crossed and lashed together about 2 ft. below their top ends, the bottom ends being 8 or 10 ft. apart, the whole stood upright on the roof, and having a "jib," or stout pole with one end lying between the top ends of the legs, and projecting a few feet, and the other end lashed down or weighted, are necessary. On the outer or projecting end of the jib lash a "block" or wheel with a groove in the edge, and around this pass a strong rope with both ends reaching the ground, and having a few feet to spare in length. The roll of lead being lashed by one end of the rope, the men pull at the other and hoist the lead to the roof. If two men are not equal to the task, and a third one cannot find room to grip the rope with

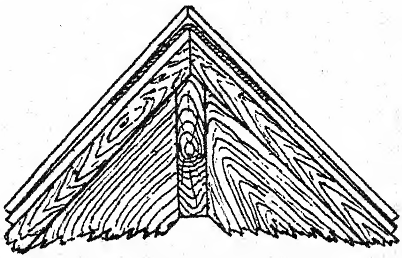


Fig. 255.—Section of Hip with Soakers.

effect, he can sometimes stand on a stage of the scaffolding above, but it is much safer to fix a "snatch-block" at the ground level, pass the rope through that, and the men, to any number, then exert a longitudinal pull. A "crab" or "winch" hoist can be used; but this, although more powerful, is not so quick as the hand-wheel. A method that could be employed by one man only would be to use a pair of pulley blocks with a $\frac{3}{4}$-in. rope and suspend these from the jib which projects from the shear-legs on the roof or flat.

Soakers and flashings are usually made of either sheet lead or sheet zinc, and are suitable for either slated or tiled roofs. An alternative, which is a little cheaper, although not so good, is to use either lead or zinc stepped flashings. Mortar or cement fillets always make a very poor job.

Lead soakers on a tiled roof are illustrated by Fig.

254. Serving the same purpose, but in a different position, is the hip soaker (Fig. 255). If a roof is covered with plain tiles of the usual size (11 in. by 7 in.), the soakers would be cut out the same width and the same length, less the amount of margin or exposed portion of a tile when finished, and plus 1 in. for turning the top end down for fixing over the head of the tile. If the latter show 4-in.

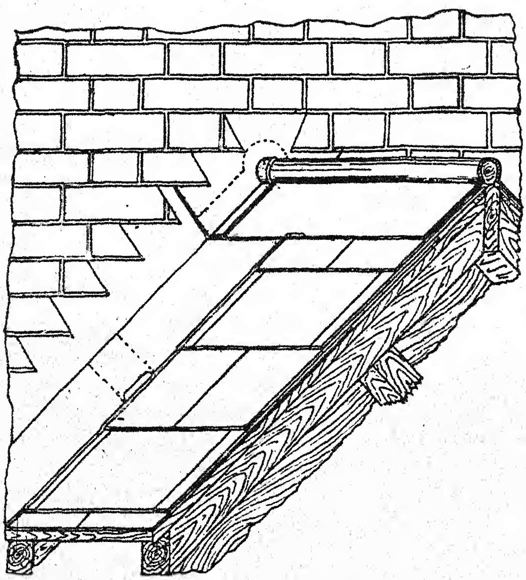


Fig. 256.—Ridge End and Step Flashing.

margins, they will have 3-in. laps, and the length of each soaker should be 4 in. + 3 in. + 1 in. = 8 in. The lead, when cut out, should be folded lengthwise down the centre, 1 in. on the top edge of the flat, or roof, part, turned down to hang on the last laid tile, and then placed in position as shown in Fig. 254. The next tile is then laid, then another soaker, and so on up to the ridge. It is usual to fix a stepped cover flashing over the stand-up parts of the soakers (see Fig. 254), but in some cases the

latter are cut 3 in. wider, so as to have 6½-in. stand-up, and the steps cut out of the soakers and turned and wedged to the wall, instead of having cover flashings. It will be understood that in Fig. 254 part of the cover flashing and part of the tiling is shown cut away to reveal the shape of the lead soaker beneath.

A view of a ridge end with step flashings is given by Fig. 256. Step flashings are also shown above the soakers

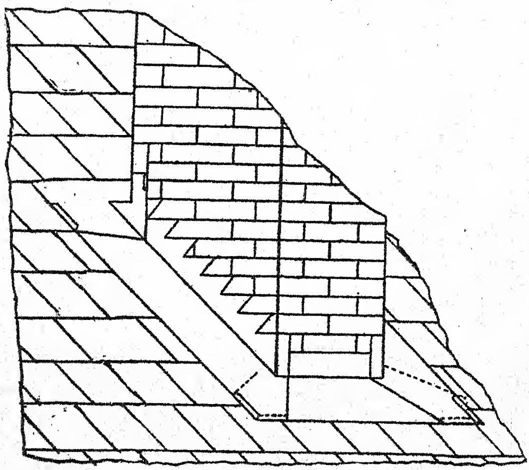


Fig. 257.—Chimney Flashing.

in Fig. 254. Chimney flashings are illustrated by Figs. 257 and 258, the latter figure showing also a break.

Information on marking off, cutting out and fixing lead step flashings will now be given. The lead should be cut out 13 in. wide, 6 in. of it to lie on the roof and 7 in. to stand against the wall. The folding line and water line should be marked with chalk, and the lead folded at right angles on the folding line. As roofs vary in their pitch or angle of slope, and as the joints of the brickwork are not always at exactly the same distance apart, the lead, after folding, should be laid in the position it is to occupy, and, with the help of a wooden straightedge, the

bottom edge of the joint in each course should be marked with a pointed piece of chalk as far as the water line, as shown at A A (Fig. 259). The lead should then be laid on a board on the wall side, and the lines B B marked, one end of this line being 1 in. from the edge of the lead, and the other end cutting the joint line on the water line. Outside the lines A A, mark those shown at C C 1 in. distant. These lines indicate the place of folding for turning into the brickwork.

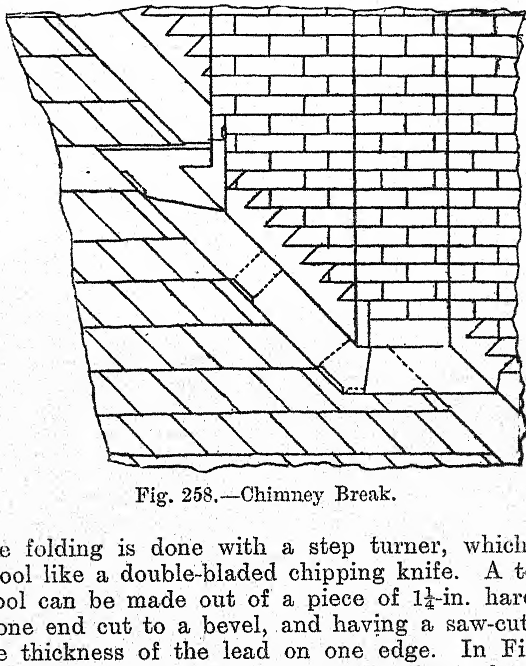


Fig. 258.—Chimney Break.

The folding is done with a step turner, which is an iron tool like a double-bladed chipping knife. A temporary tool can be made out of a piece of $1\frac{1}{4}$-in. hardwood, with one end cut to a bevel, and having a saw-cut equal to the thickness of the lead on one edge. In Fig. 259, which is drawn for a roof having a slope of 45°, the shaded parts are those which are to be cut away.

The placing of the folded lead in position for marking out the steps is perhaps better shown by Fig. 260, in which the dotted lines B indicate the joint lines of the brickwork. C denotes the position of a lead or oak wedge

when finally fixing the step flashing, and D is the lead which covers the slating and which is clipped by lead straps, 3 in. wide, secured to the brickwork about 3 ft. 6 in. apart.

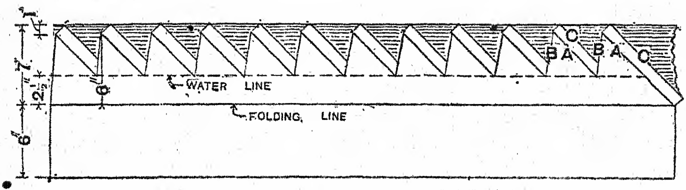


Fig. 259.—Cutting out Stepped Flashing.

Burning lead flashings to stone or terra-cotta walls is done by filling the grooves with molten lead (see Fig. 235, p. 117). The best way of running the lead is shown in Fig.

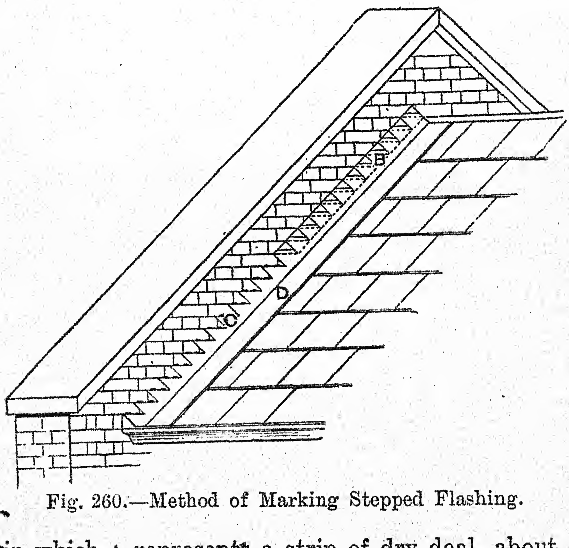


Fig. 260.—Method of Marking Stepped Flashing.

261, in which A represents a strip of dry deal, about 2 ft long by 2½ in. or 3 in. wide and 1½ in. thick, placed over the joint and held in position by struts against an opposite wall, or by a weight, as shown in the illustration.

The groove at the ends of the running stick is plugged with clap or common putty to prevent the lead escaping. The lead is poured through the two outer holes, shown on the top edge of the stick, the centre hole being left open for air to escape. The lead should not be poured too hot. When the pouring is finished and the lead has set, the stick is removed, and the face of the run lead is cross-hatched, about 1 in. apart, with a blunt hand chisel, as shown at B. The lead should not be staved or caulked in, as the stone at the edges of the groove would be chipped or stunned and eventually crumble or flake away.

A section of the groove and flashing is shown in Fig.

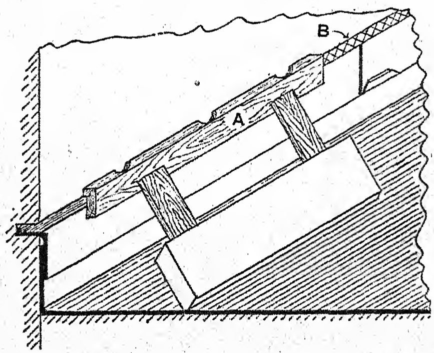



Fig. 261.—Burning in Lead Flashings.

262; A indicates the flashing and B the stick. It will be noted that the groove is slightly wider at the back than at the front.

Before describing a typical roof job, the essential requirements of such work may be stated. In good roofing work, all sheet lead is of the best quality, and made of pure soft pig. The nails are of copper, with flat heads. The gutters, cesspools, and parts of roof where there is any foot traffic, are covered with lead weighing 8 lb. per superficial foot. Excepting as above, all flats, dormer tops, valleys, chimney and skylight gutters are covered with 7-lb. lead. All hips, ridges, and dormer-cheeks are covered with 6-lb. lead. Cover and stepped flashings and

aprons are of 5-lb. lead, and soakers 4-lb. lead. The whole of the lead work must be properly bossed to suit the various positions. With the exception of soldered angles to the cesspools and the joints to the socket-pipes, no soldering whatever may be done to the lead work on roofs. The lead is to be fixed to keep it in position, but in such a manner as to allow for expansion. To prevent the lead

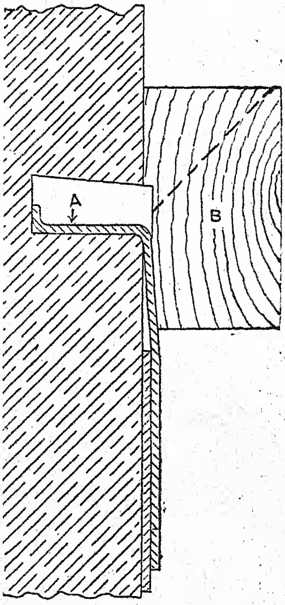



Fig. 262.—Section of Flashing and Stick.

on flats and gutters "crawling" down, they should not have a fall exceeding 2 in. in 10 ft.

For covering a sloping roof exposed to the sun, cast sheet lead is usually considered to be the best, as in it the molecules of the metal are more free to move amongst themselves than is the case in milled sheet lead, and the lead is thus less liable to fracture by the alternate expansions and contractions that take place. Fig. 263 shows

the pitch of a roof, and Fig. 264 is a plan on the slope of the roof showing the arrangement of the bays and passings. The dotted lines in the passings show the positions of grooves made to prevent water passing between the laps

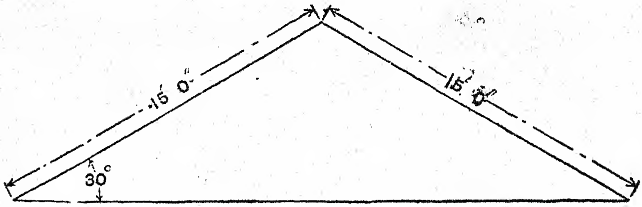



Fig. 263.—Roof Outline.

by capillary attraction. Wood roll is the better form of roll where any foot traffic passes over the roof, but the hollow roll allows more freedom for movement of the metal by expansion. As capillary action causes water to rise between the laps of lead to a vertical height of about

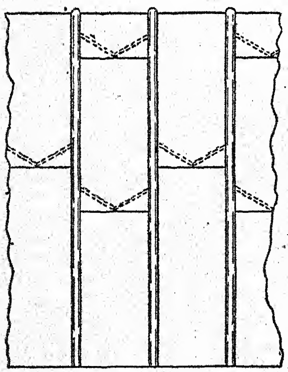


Fig. 264.—Plan of Roof Slope.

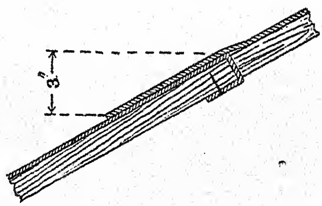



Fig. 265.—Section Showing Lap.

Fig. 266.—Section Showing Water Groove.

3 in., the length of the lap should be about equal to this, as shown in section by Fig. 265. Fig. 266 represents a section at right angles to the water grooves indicated by dotted lines in Fig. 264.

Covering a ridge with lead is by no means a difficult operation if set about in a proper manner. Before the wood roll is fixed, straps of lead about 3 in. wide, and long enough to overlap the slating about 7 in. on each side,

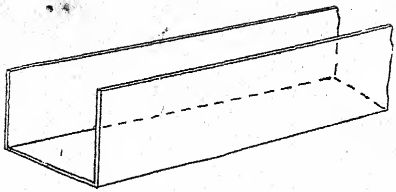


Fig. 267.—Lead for Covering Ridge.

should be nailed to the ridge-plate. For a 2-in. roll the lead can be 7 ft. to 8 ft. long, and about 1 ft. 6 in. wide. In setting out, strike a chalk line down the centre of the lead, and on each side set off half the girth of the exposed portion of the roll, which can be found by bending a strip of lead round it; the lead can then be turned up on these lines in the form of a trough (Fig. 267). If this, when placed on the top of the roll, is raised and dropped down

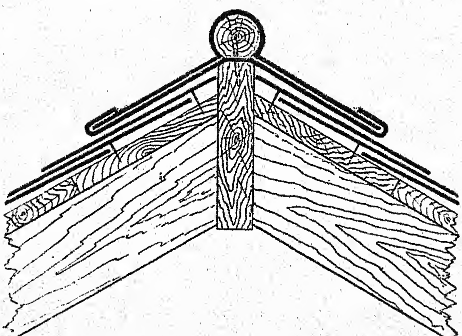


Fig. 268.—Lead-covered Ridge.

smartly, the sides will fall and cover the roll. After the lead is tightly dressed home to the sides of the roll, the straps are drawn up and turned over to clip the free edges of the wings, as shown in Fig. 268.

The construction of a dormer window is clearly shown by Figs. 269 to 271. Fig. 272 illustrates a secret tack

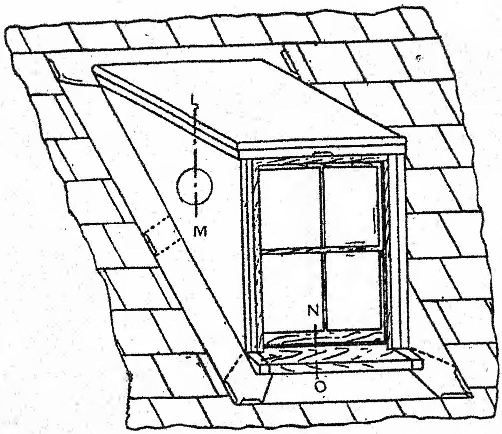


Fig. 269.—Dormer Window.

soldered at the back of the cheek instead of employing a soldered dot as in Fig. 270; a second alternative is a

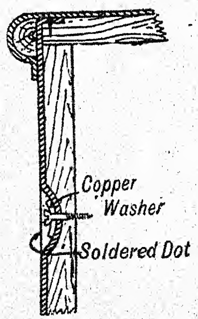


Fig. 270.—Section of Dormer Window on L M (Fig. 269).

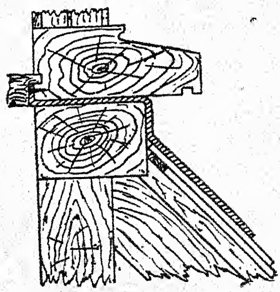


Fig. 271.—Section of Dormer Cill on N O (Fig. 269).

piece of 2-in. lead pipe soldered at the back of the cheek lead and tafted (see Fig. 273).

In covering a dormer window with sheet lead, the apron should be fixed before the window frame is put into its place, and then turned up inside and dressed to the sill. The cheeks should then be set up and dressed for 6 in. to lie on the slates, $1\frac{1}{2}$ in. to be nailed into a rebate cut into the dormer top, and 2 in. or 3 in. to return on the face, to

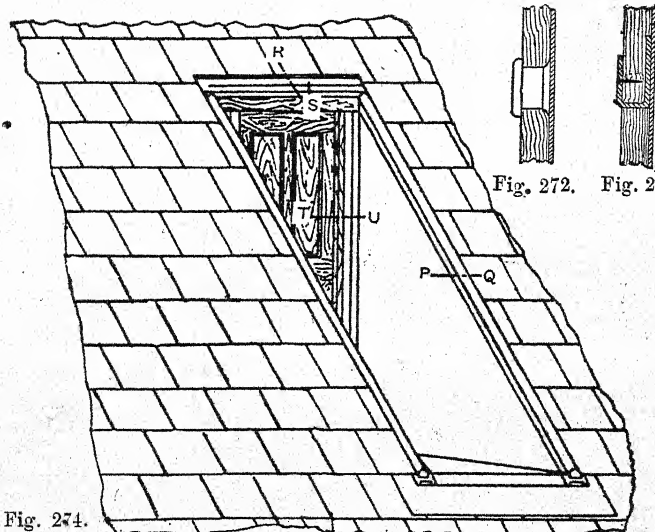



Fig. 272. Fig. 273.

Fig. 274.

Fig. 272.—Secret Soldered Tack. Fig. 273.—Alternative to Soldered Tack. Fig. 274.—Roof Doorway.

which it is usually nailed, and a flat welt turned to cover the nail heads. If the cheeks are very large, they should be put on in two or more pieces, and vertical double welts turned. Soldered dots should not be used; but if additional fixings are necessary, secret tacks should be used, as shown in Fig. 272. The top of the dormer, if not too large, should be covered with one piece of lead, and the front and sides dressed round a nosing on the edges for preventing a high wind blowing it off. The lead at the back should be continued up the roof 9 in., and dressed to a tilting piece or springing, for the eaves course of

slates to rest upon. In some cases it is necessary to fix a lead weathering on the front of the dormer for preventing rainwater getting in at the top of the sashes. All free edges of lead should have tacks for preventing wind get-

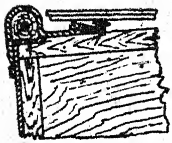


Fig. 275.

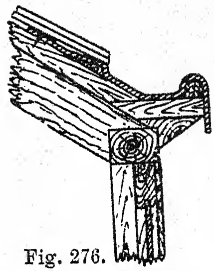


Fig. 276.

Figs. 275 and 276.—Sections of Roof Doorway on P Q and R S (Fig. 274).

ting beneath. For first-class work the apron should be 6-lb., the cheeks 7-lb., and the top 8-lb. lead. For ordinary work the above weights are 1 lb. less all round.

Details of a doorway in a roof are presented by Figs. 274 to 278.

Hatches are openings in the roof to give convenient access to the outside for the purpose of repairs, etc. They are sometimes made through flats, and sometimes through the slates of the roof, the hatch shown by Fig. 279 being of

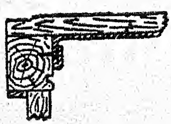


Fig. 277.—Section of Roof Doorway on T U (Fig. 274).

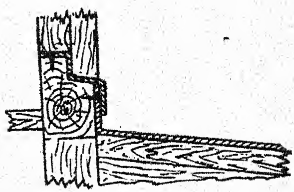


Fig. 278.—Section of Doorway Cill.

the latter kind. A convenient size is 2 ft. 6 in. by 18 in., inside measurement, the framework being 3 in. clear of the roof and $1\frac{1}{2}$ in. thick. A gutter-board, tilting fillet, etc., should be fixed at the upper end of the curb. The lead re-

quired will be as follows: Bottom A (Fig. 279), length, 1 ft. 6 in. + 1½ in. + 1½ in. + 6 in. + 6 in. = 2 ft. 9 in.; width, 6 in. + 3 in. + 1½ in. = 10½ in. Sides B B (Fig. 279), length, 2 ft. 6 in. + 1½ in. + 1½ in. + 6 in. + 1 in. (this latter for tack at C, Fig. 279) = 3 ft. 4 in.; width, 6 in. + 3 in. + 1½ in. = 10½ in. As the top piece D bosses the break, for which 1½ in. is allowed on each side, the length will be 1 ft 6 in. + 1½ in. + 1½ in. + 7½ in. + 7½ in. = 3 ft., and the width 1 ft. 8 in. The total required for the frame will therefore be one piece 2 ft. 9 in. by 10½ in., two pieces 3 ft. 4 in.



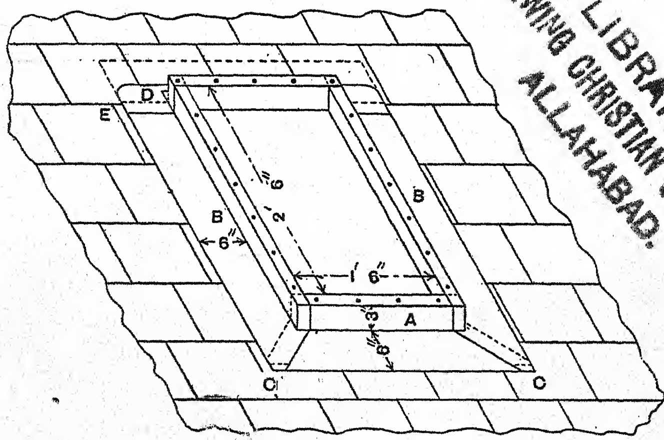



Fig. 279.—Lead-covered Hatch.

by 10½ in., and one piece 3 ft. by 1 ft. 8 in., 7-lb. lead being used for the gutter, and 5 lb. for the sides and bottom. To find the weight of the lead, add all the lengths together, and multiply by the width and weight of lead.

Soakers can be used against the sides of the hatch. The bottom piece of lead should be turned up 4½ in., the top edge being dressed on the woodwork, and nailed. Return the angle, and cut off, as shown by dotted lines (Fig. 279). The side pieces can be turned up for a similar distance at the bottom, and nailed. The small breaks at the lower corners are bossed, care being taken not to thin the

lead too much, or a bird's-eye will result. The art of lead bossing consists in making the lead of even thickness

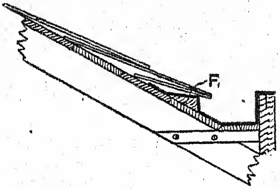



Fig. 280.—Section through Gutter.

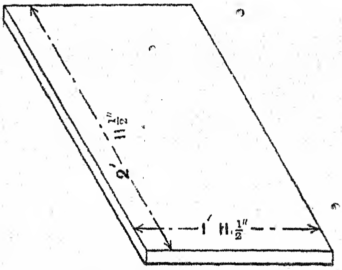



Fig. 281.—Finished Hatch Cover.

throughout, and not thick in one place and thin in another. The wood tools used for lead laying should be carefully

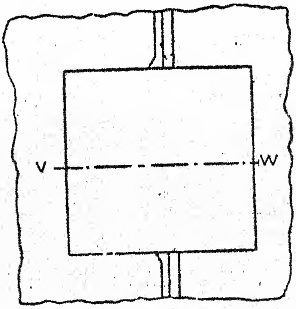



Fig. 282.

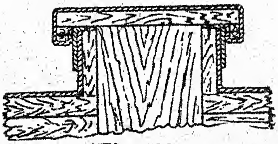


Fig. 283.

Figs. 282 and 283.—Plan and Section of Trap-door in Lead Flat.

looked after, so that they may not become damaged, as a piece of lead cannot be finished neatly if the tools used are

chipped and faulty. The bossings when finished should not show any tool mark. Draw the lead required for the breaks from the outside margins or edges. Drive with quick, swinging blows to keep the lead warm, and finish off with a rather dull dresser. Cut off as shown, and turn the

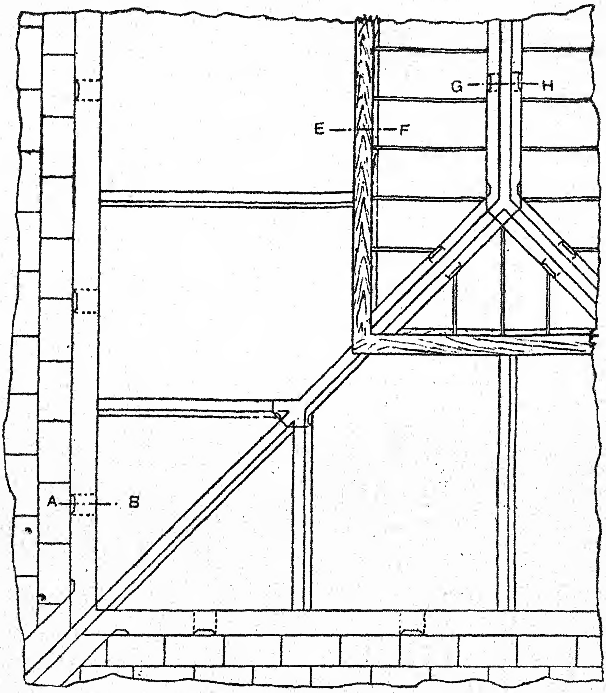



Fig. 284.—Plan of Lead Flat and Skylight.

1 in. left at C (Fig. 279) underneath to hold the corners together.

The gutter D (Fig. 279) can now be turned up 4½ in. on one side and 9 in. on the other, as seen in Fig. 280, which is a section through the gutter. Turn the top edge over, and secure it with nails; and also dress the lead over the tiling fillet F (Fig. 280). The breaks at the two ends of the

gutter are worked down. Draw the lead for them from the surplus $1\frac{1}{2}$ in. left at each end of the gutter. Boss in a similar manner as the bottom angles, and finish with a dresser and trim up. After the framework is finished, the slater can complete the slating.

The cover (Fig. 281) is 2 ft. $11\frac{1}{2}$ in. by 1 ft. $11\frac{1}{2}$ in. by $1\frac{1}{2}$ in., and is made of 1-in. stuff. The length of the lead will be 2 ft. $11\frac{1}{2}$ in. + $1\frac{1}{2}$ in. + $1\frac{1}{2}$ in. + 1 in. + 1 in. = 3 ft. $4\frac{1}{2}$ in., and the breadth 1 ft. $11\frac{1}{2}$ in. + $1\frac{1}{2}$ in. + $1\frac{1}{2}$ in. + 1 in. +

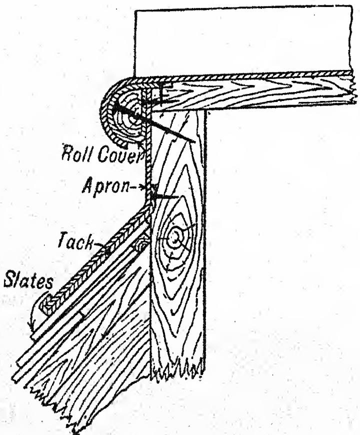



Fig. 285.

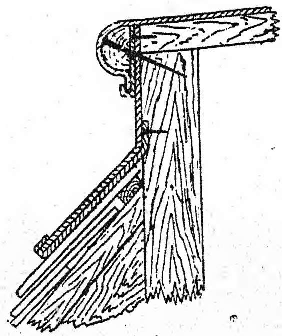


Fig. 286.

Figs. 285 and 286.—Enlarged Detail of Skylight (see A B, Fig. 284).

1 in. = 2 ft. $4\frac{1}{2}$ in. A piece of 7-lb. sheet lead 3 ft. $4\frac{1}{2}$ in. by 2 ft. $4\frac{1}{2}$ in. will therefore be required. The weight of this would be 3 ft. $4\frac{1}{2}$ in. + 2 ft. $4\frac{1}{2}$ in. + 7 lb. = 2 qr. $7\frac{1}{2}$ lb. Set up $2\frac{1}{2}$ in. on all sides, and boss up the corners. After bossing, the wood frame is turned over inside the lead, and the bottom edge bossed over and nailed. The tools required for the work will be dressers, a bossing stick, and a bossing mallet. The method of bossing corners is fully described in connection with bossing up a lead tray in Chapter III. (pp. 32 to 34). A similar construction to the hatch just described is the trap-door (Figs. 282 and 283).

Details of the construction of a skylight over a lead flat are presented by Figs. 284 to 288. It will be instructive to

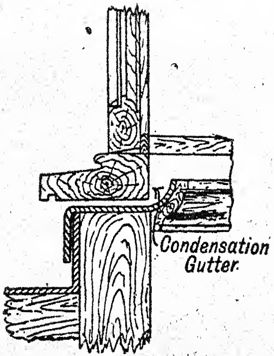



Fig. 287.—Section of Skylight on E F (Fig. 284).

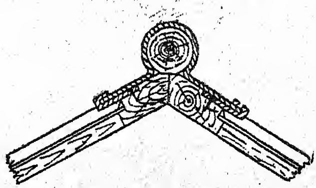


Fig. 288.—Section of Skylight on G H (Fig. 284).

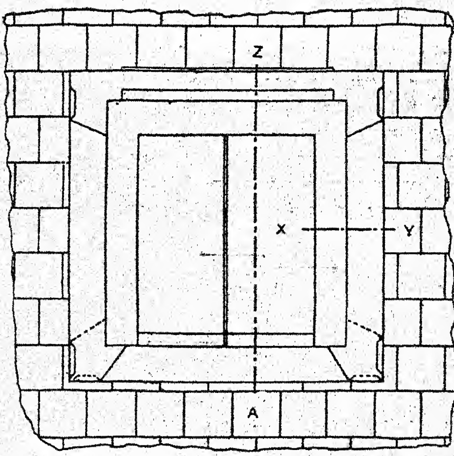



Fig. 289.—Plan of Skylight on Slated Roof.

compare these figures with Figs. 289 to 291, which illustrate a skylight erected on a slated roof.

Fig. 292 is a scale drawing of a small turret roof, and

below is described the method of covering such a roof with lead, the bays to have $1\frac{3}{4}$-in. seam rolls (with copper tacks) in the centre and at the angles. Before putting on the lead, the woodwork should be prepared by cutting off the sharp arrises of the hips and sinking a rebate on the dotted

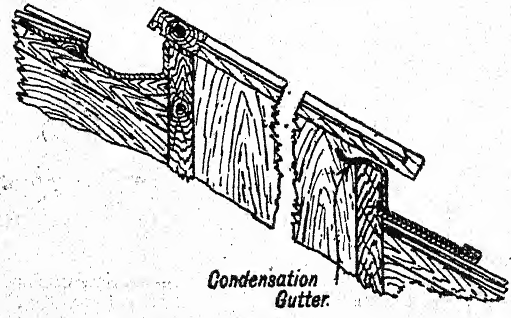



Fig. 290.—Section of Skylight on Z A (Fig. 289).

line A (Fig. 292) to a depth equal to the thickness of the lead. Aprons, one on each side, dressed into the rebate and secured with copper nails, should then be fixed, the ends of the aprons being worked round the angles, and tacks turned, as shown at B. In practice it would be a difficult matter to make a really smart job unless wood rolls were used; however, a City Guilds question in Plumbers'

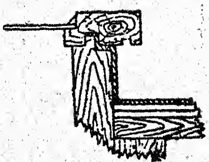


Fig. 291.—Enlarged Section of Skylight on X Y (Fig. 289).

Work (Honours) for the year 1899 specified seam rolls, and these will be considered here.

The position of the rolls should be set out on the actual turret, the widths of the rolls, less one thickness of lead, being shown, and copper tacks 4 in. long by 3 in. wide,

and about 18 in. apart, or three in the whole length, screwed on so as to come beneath the roll. These tacks are to be turned over the undercloak, a space being left at c as shown in Fig. 293, after the first bay has been placed in position. So as not to distress the lead, or reduce the

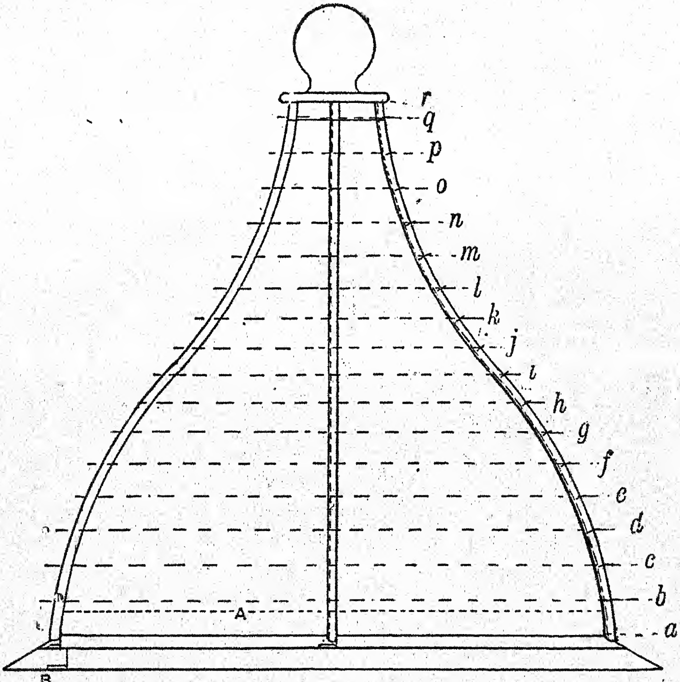



Fig. 292.—Side Elevation of Turret Roof.

thickness in the angles, the lead should be set out the exact size as shown in Fig. 294, and the parts for the undercloak and the overcloak turned and dressed down flat, and the corners partly worked to suit the bottom ends of the rolls. The bay is then placed in position, flapped to the hollow and round of the roof, and the sides worked upright, and then turned and folded to form the hollow rolls.

Great pains should be taken when doing this, or the rolls will become full of bruises and tool marks, which cannot be taken out. Neither should the overcloak be turned too tightly, or the lead will be pulled up as shown by dotted lines at D (Fig. 295), and probably broken or torn if an endeavour is made to work it down to form an angle.

For covering the apex, or ball, a circular piece of lead is to be cut out, partly worked on a horse, then placed in position and dressed down to lie about 4 in. on the roof. To protect the top ends of the rolls and keep them from being bruised they may be temporarily covered over with

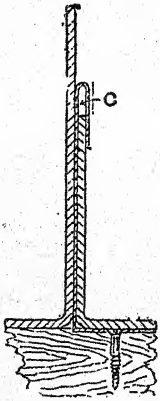



Fig. 293.—Roll Before Folding.

saddle pieces of thin sheet-iron or copper. Of the illustra tions, Figs. 292 and 294 are drawn to a scale of ½ in. to 1 ft., and Figs. 293 and 295 are half full-size.

For finding the true shape of the bays, one side of the contour of Fig. 292 is first divided into any number of equal spaces as from *a* to *r* inclusive, and from these points lines are projected across the figure. The dotted line inside the centre roll (Fig. 292) and the line E (Fig 294) represent the creasing or folding line for the undercloak. The latter line, in Fig. 294, is divided into spaces equal to those on the contour of Fig. 292; horizontal lines drawn through them and the length of each line taken off with a pair of com-

passes are marked on Fig. 294, and the points thus found are joined by freehand. The necessary distances, which can be found from Fig. 293, being marked for the undercloak and the overcloak respectively, show the margins for cutting out. The other, or left-hand, bay is set out in a similar manner, except that it is the other hand, and the

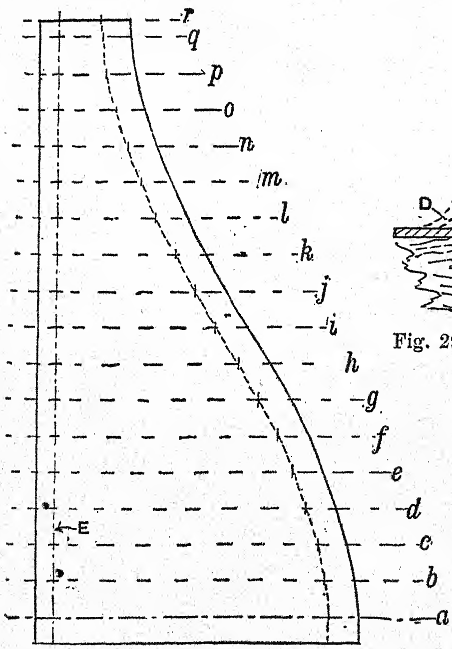



Fig. 294.—Lead Bay for Turret Roof.

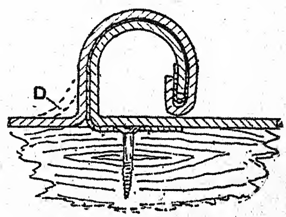



Fig. 295.—Section of Centre Roll.

horizontal distances should be taken from the firm lines which show the sides of the centre and hip rolls.

The term "herringbone" is applied to a certain way in which the rolls are fixed on a dome or turret to be covered with lead. In addition to the rolls from the base to the apex, are others which are fixed slantwise between them. These sloping rolls sometimes intersect about midway in the bays. In addition to giving an ornamental appearance,

they form a very good fixing for the lead and prevent it "crawling" downwards under atmospheric influences. The

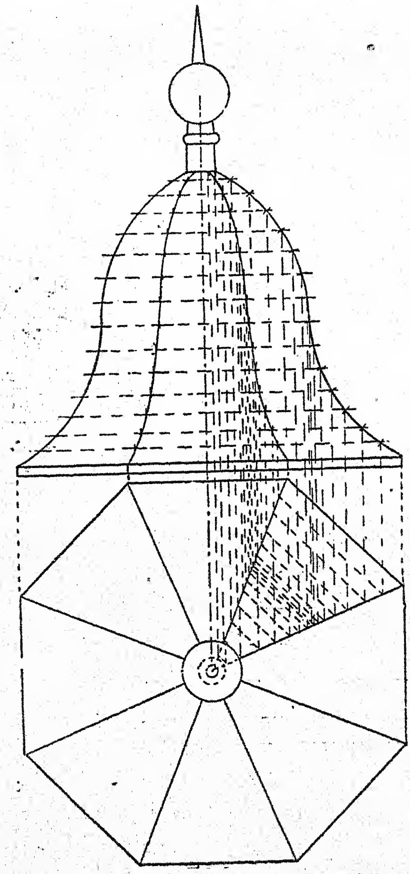


Fig. 296.—Elevation and Plan of Octagonal Turret Roof.

head is cut to shape and bossed to the rolls as for ordinary lead work on roofs.

The best method of setting out lead bays for an

octagonal turret roof is as follows: If the roof is already constructed, horizontal lines should be drawn between the hip rolls at equal distances (say 6 in.) apart, measured on the surface of the roof as shown in the elevation half of Fig. 296. The lower half of the figure, and the vertical dotted lines, are drawn only as aids to finding the true position in the elevation of the hip rolls to the centre bay, so as to be able to measure the width of the latter at all parts. Similar horizontal, and a centre perpendicular, lines must be drawn on the piece of lead to be used, and the dimensions transferred one at a time from the roof to

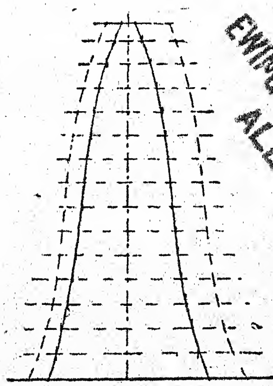




Fig. 297.—Lead Bay for Octagonal Turret Roof.

the lead, and the points joined together by freehand, as shown by Fig. 297. Outside the lines thus found, draw others 4 in. and 8 in. distant for the undercloak and overcloak respectively. The sides of the bay must be then bossed upright; or, if the contour of the roof is very round or very hollow, they can be doubled down flat until placed in position, and afterwards worked up and dressed to the rolls. If the bays are not very large, the nailing on the top end, and also the undercloaks to the rolls, will support them. With a roof of this shape, the grip of the metal on the rolls will also help to support it. If the bays are put on in two pieces, or if laced rolls are used between the hip rolls, further support is obtained without the use

of soldered dots. About three copper tacks can be used to each bay to hold up the bottom edge. The covering for the top should be bossed out of a round piece of lead, and the bottom edge should lie on the roof for from 6 in. to 9 in., to cover the nailing and make it watertight at that point. Copper nails should be used in preference to iron.

The covering of domes—hemispheres—with sheet lead will now be described. Seam rolls should be made, as lead on a dome with wooden rolls almost invariably leaks at the parts close to the base, which are nearly upright. With a dome 50 ft. in diameter the bays of 8-lb. lead could not be cut out of one piece of metal; neither would it be advisable to do so, as the fixings would not be strong. Horizontal laps would have to be arranged on an average of 7 ft. apart. The lower laps should be about 6 in.; those nearer the apex 12 in. For the rolls to average 2 ft. 3 in. apart, measured on centres, the width at the base would be about 4 ft. 6 in. The number of rolls may be 3·1416 × 50 ÷ 4 ft. 6 in. = 35. As it would be difficult to make a good finish at the apex if all the rolls were to meet at a point, they should be cut about 3 ft. short, and they should be made to finish at a drip to a raised portion, a capping piece of lead being fixed over the whole.

In measuring a dome of this kind it is best to measure the surface, and to this add the extra lead on the rolls, laps, and on the edge of the capping which is worked over the top ends of the rolls. The dome surface measures 50 ft. × 3·1416 × 25 ft. (or half the diameter) = 3,927 ft. superficial. The length of rolls is 50 × 3·1416 ÷ 4 = 39·27, and from this − 3 ft. = 36·27, or, say, 36 ft. 3 in., to which should be added 3 in. for dressing on the drip at the top end, thus making a net length of 36 ft. 6 in. On setting out a section of the roll, if the finished roll is 2 in. across and stands 2 in. above the boarding, the "undercloak" requires $3\frac{1}{2}$ in. of lead and the "overcloak" 6 in. of lead. Therefore 36 ft. 6 in. × $9\frac{1}{2}$ in. = 28′ 10″ 9‴. This, multiplied by the number of rolls, gives: 28′ 10″ 9‴ × 35 = 1,011′ 4″ 3‴—the total net amount of lead in rolls.

The number of horizontal laps in the bays = 36 ft. 3 in. ÷ 7 = 5, the number of pieces of lead which − 1 = 4 as the number of laps. The depth of the laps = 6 in. + 1 ft. ÷ 2 = 9 in. as an approximate average. For length of laps,

2 ft. 3 in. (net length) + $9\frac{1}{2}$ in. (in rolls) = 3 ft. $\frac{1}{2}$ in., and 3 ft. $\frac{1}{2}$ in. × 9 in. = 2 ft. $3\frac{1}{2}$ in. nearly. And 2 ft. $3\frac{1}{2}$ in. × 4 × 35 = 320′ 10″ superficial as the extra amount of lead in laps.

Assuming that the capping lead laps 6 in. on the roll ends and drip, there will be an extra on the dimensions of a ring of lead 6 in. wide and measuring 6 ft. inside. Then 7 ft. (outside dimension) squared and × ·7854 = 38·4846. From this deduct the inner piece, which was measured in the dome, = 6 ft. squared × ·7854 = 28′·2744. Then 38·4846 − 28·2744 = 10′·2102 or 10 ft. 3 in. (nearly) as the size of the extra lead on margin of capping. Then

| ft. | in. | |
|---|---|---|
| 3,927 | 0 | on dome |
| 1,011 | $4\frac{1}{4}$ | extra on rolls |
| 320 | 10 | ,, laps |
| 10 | 3 | ,, capping |
| 5,269 | $5\frac{1}{4}$ | total superficial feet |
| | 8 | lb. lead |
| 42,155 | 6 | lb. of lead |

or 18 tons 16 cwt. 1 qr. $15\frac{1}{2}$ lbs. as the total weight of lead necessary to cover the dome.

The simplest method of measuring up the lead on a dome is to measure up the superficial area of the dome, and add to that sum sufficient to account for all rolls and passings, etc. To find the area of a dome, assume that it is a true hemisphere, the rule is: Diameter of base × 3·1416 × vertical height. Example: A dome 20 ft. in diameter, and covered with 7-lb. sheet lead; 20 × 3·1416 × 10 = 628·32 super. ft. This dimension × 7 = 4398·24 lb. = weight of lead on the dome. On such a dome would be about twenty-six rolls, running from the eaves to the apex; and each roll would require a strip of lead 8 in. in width. The length of the rolls would be (20 × 3·1416) ÷ 4 = 15·7, or say, 15 ft. 9 in. Then 15 ft. 9 in. × 8 in. × 26 × 7 lb. = 1911 lb. Added together = 4398·24 + 1911 = 6309·24 lb., or 2 tons 16 cwt. $27\frac{1}{4}$ lb. = the total weight of the dome. Any horizontal laps or passings, owing to the bays being put on in two or more pieces, would have to be allowed

for, and the extra weight added to the above total. A further allowance would have to be made if an apron were fixed round the base, or any ornament or finial fixed on the apex.

Below is described the correct method of covering a wood finial with lead. It is assumed that the finial surmounts a slated roof that has lead hip rolls. The hip rolls should first be covered with lead in the ordinary way, the top ends of the lead being well nailed to the wood rolls near the finial. The wood base of the latter should be rebated, about 3 in. up from the roof, and a lead apron put on, the bottom lying on the slates about 1 ft. or 18 in., and be worked over the hip rolls, the top edge being

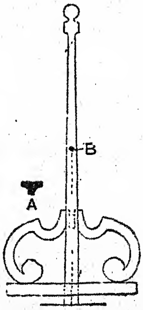



Fig. 293.—Lead-covered Finial.

dressed into the rebate. The finial can then be covered with a piece of sheet lead bossed to the shape, or a piece of 4-in. or $4\frac{1}{2}$-in. lead pipe placed on the wood block, the neck worked in beneath the ball, and then the top end closed by bossing. A skilful plumber would cover the finial with one piece of lead and have it large enough to lay on the slated roof some 2 ft. or 3 ft., and trim the bottom edge to an ornamental pattern; but one who was not skilled should not attempt this, as he would most likely break all the heading slates, and there would be considerable difficulty in repairing them.

For use in covering the wood finial of a dormer window with 6-lb. lead, the finial being 2 ft. high and $2\frac{1}{2}$ in. in diameter, with a $4\frac{1}{2}$-in. ball on top, prepare a mandrel

$4\frac{3}{4}$ in. diameter and 2 ft. long, one end made quite round. Work an upstand in the centre of a piece of sheet-lead that will cover this mandrel, pass the lead over the finial, and dress the lead close on to the wood of the finial and down the ridges as an apron. The mandrel may be made of any kind of wood, and need not have the same finish as a pipe mandrel. An alternative method is to get a piece of sheet lead 2 ft. 6 in. long by 15 in. wide, and burn the two edges together. This burning can be done as described in Chapter VI., or the lead can be laid on a piece of board 3 ft. long by 3 in. wide, with the top covered with paper well smeared with tallow, and two hatched-shaped soldering bolts used red-hot, with a strip of lead as solder, and plenty of tallow as a flux. There will thus be obtained the equivalent of a piece of drawn pipe. By bossing one end over into the shape of half a ball and soldering the small hole at the top, it can be dropped over the finial and dressed to the smaller part.

The finial shown by Fig. 298 is 8 ft. 6 in. high, turned and moulded out of 6-in. by 6-in. wood; the scroll feet are four in number with 1 ft. 9 in. projection, 2 ft. 3 in. high and 6 in. thick. The base has four arms, each 1 ft. 9 in. long. In covering such a finial with lead, the four-armed base should be covered first. To do this lay the wood block on a piece of 7-lb. sheet lead and scribe all round with a pair of blunt compasses set to a width of 11 in., leaving a gusset piece in the internal angles for working up the break. Boss the lead to the sides and work over the top edges. Then begin at the outer ends of the arms and boss seams from the ends towards the centre, leaving the latter part open and standing up 3 in. high for bossing round the terminal post. Another method would be to boss the lead to the sides and 1 in. over the top edge, then burn in a piece of lead to cover the top side and work up holes on the top and bottom sides to fit round the post. The post B A can be covered with a piece of $7\frac{1}{2}$-in. or 8-in. 7-lb. lead soil pipe bossed tightly home to the woodwork. The curved feet can be covered with strips of lead 14 in. wide, bent all round the top and bottom sides of the scroll and then bossed on each cheek or side until the edges of the lead meet in the centre of the cheeks. The seam down the centre of each cheek can be bossed or burned together.

# INDEX.

PRINTED BY CASSELL AND COMPANY, LIMITED, LUDGATE HILL, LONDON, E.C.

[Continued overleaf.

## "WORK" HANDBOOKS (*continued*).

**Mounting and Framing Pictures.** *Contents.*—Making Picture Frames. Notes on Art Frames. Picture Frame Cramps. Making Oxford Frames. Gilding Picture Frames. Methods of Mounting Pictures. Making Photograph Frames. Frames covered with Plush and Cork. Hanging and Packing Pictures.

**Smiths' Work.** *Contents.*—Forges and Appliances. Hand Tools. Drawing Down and Upsetting. Welding and Punching. Conditions of Work: Principles of Formation. Bending and Ring Making. Miscellaneous Examples of Forged Work. Cranks, Model Work, and Die Forging, etc. etc.

**Glass Working by Heat and Abrasion.** *Contents.*—Appliances used in Glass Blowing. Manipulating Glass Tubing. Blowing Bulbs and Flasks. Jointing Tubes to Bulbs forming Thistle Funnels, etc. Blowing and Etching Glass Fancy Articles: Embossing and Gilding Flat Surfaces. Utilising Broken Glass Apparatus: Boring Holes in and Riveting Glass. Hand-working of Telescope Specula. Turning, Chipping, and Grinding Glass. The Manufacture of Glass, etc.

**Building Model Boats.** *Contents.*—Building Model Yachts. Rigging and Sailing Model Yachts. Making and Fitting Simple Model Boats. Building a Model Atlantic Liner. Vertical Engine for a Model Launch. Model Launch Engine with Reversing Gear, etc. etc.

**Electric Bells, How to Make and Fit Them.** *Contents.*—The Electric Current and the Laws that Govern it. Current Conductors used in Electric Bell Work. Wiring for Electric Bells. Elaborated Systems of Wiring; Burglar Alarms. Batteries for Electric Bells. The Construction of Electric Bells, Pushes, etc. etc.

**Bamboo Work.** *Contents.*—Bamboo: Its Sources and Uses. How to Work Bamboo. Bamboo Tables. Bamboo Chairs and Seats. Bamboo Bedroom Furniture. Bamboo Hall Racks and Stands. Bamboo Music Racks. Bamboo Cabinets and Bookcases, etc. etc.

**Taxidermy.** *Contents.*—Skinning Birds. Stuffing and Mounting Birds. Skinning and Stuffing Mammals. Mounting Animals' Horned Heads: Polishing and Mounting Horns. Skinning, Stuffing, and Casting Fish. Preserving, Cleaning, and Dyeing Skins, etc. etc.

**Tailoring.** *Contents.*—Tailors' Requisites and Methods of Stitching. Simple Repairs and Pressing. Re-lining, Re-pocketing, and Re-collaring. How to Cut and Make Trousers. How to Cut and Make Vests. Cutting and Making Lounge and Reefer Jackets, etc. etc.

**Photographic Cameras and Accessories.** *Contents.*—Photographic Lenses and how to Test them. Modern Half-plate Cameras. Hand and Pocket Cameras. Ferrotype Cameras. Stereoscopic Cameras. Enlarging Cameras. Dark Slides. Exposure Shutters. Camera Stands. Index.

**Optical Lanterns.** *Contents.*—Single Lanterns. Dissolving View Lanterns. Illuminants for Optical Lanterns. Optical Lantern Accessories. Conducting a Limelight Lantern Exhibition. Experiments with Optical Lanterns. Painting Lantern Slides. Photographic Lantern Slides, etc. etc.

**Engraving Metals.** *Contents.*—Introduction and Terms Used. Engravers' Tools and their Uses. Elementary Exercises in Engraving. Engraving Plate and Precious Metals. Engraving Monograms. Transfer Processes of Engraving Metals. Engraving Name Plates. Engraving Coffin Plates. Engraving Steel Plates. Chasing and Embossing Metals. Etching Metals. Index.

**Basket Work.** *Contents.*—Tools and Materials. Simple Baskets. Grocers' Square Baskets. Round Baskets. Oval Baskets. Flat Fruit Baskets. Wicker Elbow Chairs. Basket Bottle-casings. Doctors' and Chemists' Baskets. Fancy Basket Work. Sussex Trug Basket, etc. etc.

**Bookbinding.** *Contents.*—Bookbinders' Appliances. Folding Printed Book Sheets. Beating and Sewing. Rounding, Backing, and Cover Cutting. Cutting Book Edges. Covering Books. Cloth-bound Books, Pamphlets, etc. Account Books, Ledgers, etc. Colouring and Marbling Book Edges. Gilding Book Edges. Sprinkling and Marbling Book Covers, etc. etc.

**Bent Ironwork.** *Contents.*—Tools and Materials. Bending and Working Strip Iron. Simple Exercises in Bent Iron. Floral Ornaments for Bent Ironwork—Candlesticks, Hall Lanterns, Screens, Grilles, etc., Table Lamps, Suspended Lamps and Flower Bowls, etc. etc.

**Photography.** *Contents.*—The Camera and its Accessories. The Studio and Dark Room. Plates. Exposure. Developing and Fixing Negatives. Intensification and Reduction of Negatives. Portraiture and Picture Composition. Flashlight Photography. Retouching Negatives. Process of Printing from Negatives. Mounting and Finishing Prints, etc. etc.

**Other Volumes in Preparation.**

CASSELL & COMPANY, LIMITED, *La Belle Sauvage, London, E.C.*